PRACTICAL STREET CONSTRUCTION

Planning Streets and Designing and Constructing the Details of Street Surface, Subsurface and Supersurface Structures

Reprinted from a Series of Articles
which appeared in

MUNICIPAL JOURNAL

During the year 1916

PROFUSELY ILLUSTRATED
with Photographs, Maps and Diagrams

New York
Municipal Journal and Engineer
1916

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PREFACE

Somewhere between twenty-five and sixty per cent. of the entire built-up area of the average American city is in its streets; and in them is to be found one-third (in value) of all its property also. Every citizen is dependent, in his business and his very existence, upon the streets—the traffic on them, the conduits under them, and the air and light from the space above them. Consequently mistakes made in the laying out or original construction of a city's streets entail on all its citizens unnecessary discomforts and expenses for all time.

Many books have been written upon the paving of streets, others upon the artistic treatment of street exteriors; but the discussion of alignment, grade and cross-section; of location of sewers and other underground constructions, and their above-ground appurtenances such as manholes and fire hydrants; of fire alarm boxes, shade trees and street signs, and of the score of other features that go to make up the complex modern city street—all of these considered each with respect to its interrelation with all the others—such a treatment of street construction has, we believe, not been attempted before with anything like the detail to be found in this volume.

It has been the aim and constant thought to make each chapter of real, practical value to the city engineer in connection with his professional work, and to introduce no unnecessary or inappropriate matter. Diagrams and photographs are used in abundance, but never merely for decorative purposes—always because of some instructive idea which it illustrates. Throughout there has been kept in mind the needs of the young engineer or one who has had little practice in municipal work; but it is believed that those more experienced will find in this book many ideas that will be helpful to them, or at the very least

can use it to advantage as a reference book with which to refresh their memories from time to time as new problems arise or necessity for new methods.

The twenty-eight chapters herein contained appeared as so many installments in "Municipal Journal" during the year 1916. Most of them were written by the editorial department of that journal, but four had special origins. One chapter, that entitled "Street Planning in Newark," is an abstract of part of a report by the City Plan Commission of that city. Chapters IX and X were written for Municipal Journal by H. C. Hutchins. Chapter XV, as explained therein, consists largely of extracts from a report of the Philadelphia Board of Surveyors. For the facts and ideas in the other chapters no special credit can be given; they have been gleaned here and there from articles, papers and reports written by scores of engineers, and from the experience and observation of the editor of Municipal Journal.

PRACTICAL STREET CONSTRUCTION

CHAPTER I.

WHAT STREETS ARE USED FOR

It falls to the lot of few men to design a city street plan entire, with no limitations imposed by existing streets or roads. Occasionally there is built a Pullman, a Gary, a Roebling or a Forest Hills; but the great majority of problems or opportunities presented to the city planner have to do with modifying old plans which have been found to be inadequate, or at best with designing the street lay-out for an extension or suburban development of an existing city. But whatever the extent or conditions of the problem, there are certain principles and aims which should control so far as circumstances will permit. Above all, the designer should be practical and remember that he is generally confronted with a condition and not a theory; which condition is often a combination of existing structures, limited resources and local prejudices. But practical solutions, to be enduringly successful, must approach as near to sound theory as conditions will permit; and such theory should be investigated and continually borne in mind.

USES MADE OF STREETS.

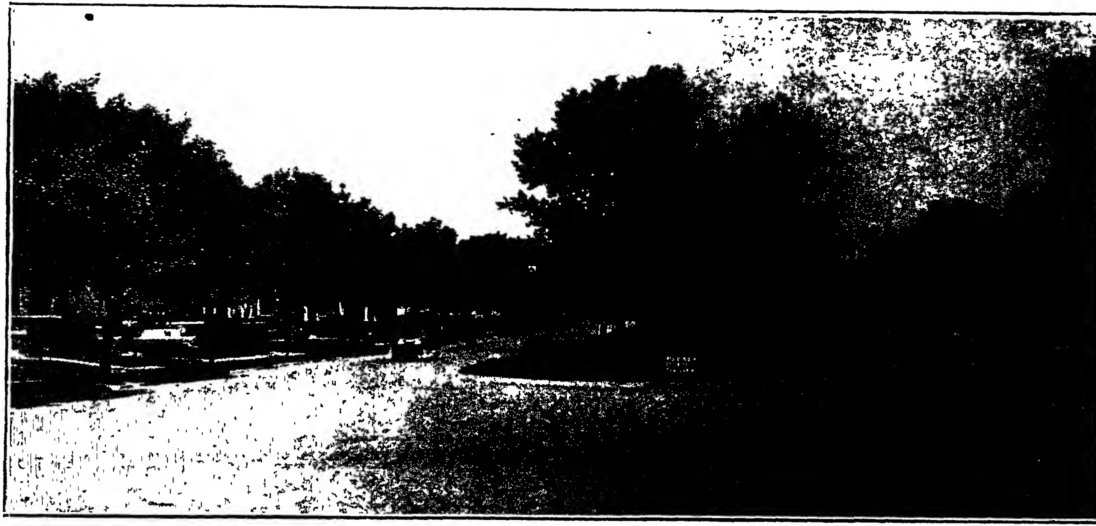
A street in a modern city is more than a traffic way—it is used for dozens of other legitimate purposes, and the street as a whole and each of its several features should be designed with the idea always in mind of securing as perfect as possible adaptation of each feature to all the others in appearance, convenience, economy and effectiveness. This is perhaps the most serious defect in most of our streets—water, paving, lighting and sewer departments, street railway, gas, steam-heating and sev-

Courtesy, Granite Paving Block Manufacturers' Association.
FIG 1—AN ELEVATED RAILROAD WHICH INTERFERES WITH SURFACE TRAFFIC.

eral telegraph and telephone companies, each constructs with little thought of the other or control by any central authority; and in many cities the private citizen is allowed to add to the confusion by building curb and sidewalk, planting trees and erecting signs and awnings of almost any kind and in any way he pleases, and erecting buildings of any desired height, regardless of street width or other conditions.

As a single illustration of the folly of all this, the main streets of every large city have under their pavements a maze of pipes and conduits which are located with no system whatever; and we venture the assertion that there is no city of the country more than twenty-five years old (and less than a score of younger ones) which has a complete record of what is buried in its streets and the position of each. The result is that the placing of any additional structures in such streets costs at least double what it should or would if all these underground structures had been placed originally according

FIG. 2—SECONDARY RESIDENCE THOROFARE



Courtesy Barber Asphalt Paving Co

FIG. 3.—BOULEVARD WITH CENTRAL PARKWAY.

to some reasonable system. Nor is this confined to large cities. We have in mind an instance where, in a town of 25,000, the cost of building one block of sewer was increased by $200 by the unsuspected presence of a water main cutting diagonally across the trench; and this could be duplicated scores of times from the writer's personal experience.

In order to secure, so far as possible, an adaptation of a street to each of its functions, before planning any detail of a street, even its location or grade, we should consider every purpose which the street may be called upon to serve, so far as we can foresee them, and give each purpose due consideration.

Every street or public way serves at least one of the following purposes, most serve more than one, a few serve most of them, but no street serves all:

1. To carry through wheel traffic on roadway.
2. To carry through foot traffic on sidewalk.
3. To carry wheel traffic to the abutting property.
4. To carry foot traffic to the abutting property.
5. To provide standing space for pedestrians to inspect shopwindows.
6. To provide stopping places for vehicles near each property.
7. To carry rapid transit vehicles on its surface.
8. To carry rapid transit vehicles above its surface.

FIG 1—A TOO NARROW THOROFARE

9. To carry rapid transit vehicles below its surface.
10. To furnish light to the abutting properties.
11. To furnish air to the abutting properties.
12. To provide public stands for farmers, push-cart men, etc.
13. To provide for loading and unloading between buildings and trucks or delivery wagons.
14. To drain surface water from abutting properties as well as its own surface.
15. To provide for pedestrians to cross roadways.
16. To provide waiting places for rapid transit passengers.
17. To provide for access by fire apparatus and use of ladders and other appliances.

To provide space above or below the surface for

18. Telegraph wires.
19. Telephone wires.
20. Trolley wires.
21. Water mains.
22. Gas mains.
23. Sewers.
24. Central steam heating mains.

[illegible] each to abutting properties.

[illegible] convenient to the surface for

[illegible] boxes.

28. Fire alarm boxes.
29. Police alarm boxes.
30. Street name signs.
31. Surface water inlets.
32. Manhole openings to give access to each of the subsurface structures.
33. Coal holes for private sidewalks vaults or basements.
34. Valve boxes to give access by rod to valves on the several pipe lines.
35. Waste paper or trash boxes.
36. To afford convenience and pleasure by means of shade trees, grassed strips, pleasing vistas, architectural features, monuments, small parks, drinking fountains for man and beast, public comfort stations.
37. Furnishing playgrounds for children. (Some cities have recognized this as a legitimate use of streets, even to the extent of closing certain streets to vehicles during a few hours each day.)

And there are undoubtedly a number of other uses which have been overlooked in the list.

Several of the items have various subdivisions. For instance, wheel traffic may be horse-drawn or automo-

bile, 10-ton trucks or light runabouts, rapid or slow. Rapid transit vehicles may be run by self-contained power, by aerial trolley or by underground trolley, or may not use rails. Surface drainage may be diverted to sewers every two or three hundred feet, or may flow in gutters for a mile or more. Some residents desire privacy for their houses, others wish to live right on a busy sidewalk. The climate is a most important factor to be considered in designing many kinds of structures and appliances; the possibility of freezing and the greater desirability of shade being two features.

In addition to these uses, every street should be lighted at night and provision made therefor; and certain features of construction may be added or modified to facilitate cleaning the streets, removing refuse from adjacent buildings etc.

In all of the planning, building and maintaining of streets and each of their details, the health, safety, convenience, comfort and pleasure of its citizens should be considered, and due attention paid to economy.

It is our intention to discuss each of these several uses

FIG. 5—IMPROPER USE OF SIDEWALK

In Figure 5 is shown a street in a large manufacturing city where the area available for pedestrians is reduced more than one-half by the clutter of signs and goods This is not

and functions with the idea of determining what methods of providing for them are available and which are best to use under various conditions—what alignment, grade and width to give each street to serve best its traffic; what width and direction of street is desirable for furnishing light and air; what cross-section of street is best adapted for warehouse, retail shopping, pleasure and other streets; how to meet the difficulties presented by steep hillsides; where it is most desirable to place each of the several pipe lines and other underground conduits, fire alarm and letter boxes, street signs, surface water inlets and other appurtenances of the street; etc., etc.

Before taking up the detailed consideration of these matters it seems desirable to consider the various kinds of public ways and the names given to them; for it is evident that with such multitudinous functions applying in various combinations and degrees to different streets, there will (or should be) great differences in the streets themselves.

CLASSIFICATION OF STREETS.

The fundamental and most important use of any street is to carry traffic—foot, hoof or wheel; through or local; from ten-ton trucks to baby carriages; horse-drawn or motor-driven, and at rates of speed from two miles an hour to the legal limit. When a street is used for any other purpose it is because it offers the most favorable or cheapest opportunity for this; frequently because the citizens permit private individuals or corporations to save themselves expense at that of the people at large. But the traffic in a street is what characterizes it.

Perhaps the most important classification of streets is according to whether the traffic is purely local or is through; whether teams and pedestrians use the street only to visit the dwellings or other buildings fronting on it, or pass through it in going from one part of the city to another. The former are called local or by-streets, the latter are given various names, such as avenues, boulevards, etc., but may all be styled thorofares. A street which is connected with other streets at one

end only is essentially a local street; but there are numerous streets in every city which are used as secluded or out-of-the-way residence streets, not on a direct line of any traffic, which come under this head. On the other hand, Broadway, New York; Washington street, Boston; Broad street, Philadelphia; Euclid avenue, Cleveland, are essentially thorofares.

But this idea must not be confused with *amount* of traffic. A business street may be crowded with traffic, all of which is not on its way *through*, but to the stores which are located on it; that is, in the heart of the business district the traffic is largely local; in fact, through traffic should be kept out of it as much as possible to minimize congestion.

Since the thorofare is primarily for the use of the public at large, it should take precedence over the local streets both in order of planning and in the adjusting of conflicting grades, locations or other features. In designing, constructing and maintaining a thoroughfare, private convenience and preferences should be subordinated to those of the public. It requires greater width and more expensive paving, lighting and treatment in general. Since these are for the citizens generally and not to benefit abutting property, any additional cost incurred in securing them should be a public expense.

In local streets, on the other hand, the residents should receive first consideration, the citizens at large having no interests there except to prevent the creation of nuisances, to secure conditions making for the health of the residents, and to enforce the law. (It is, of course, understood that certain services, such as street lighting and cleaning, sewers, water supply, etc., are provided to all parts of the city as equal personal rights.) It might, indeed, be argued with considerable reason that in the case of purely local streets, the planning of alignment, grade, width, size of lot, etc., should be left entirely to the owners, under such restrictions only as are designed to prevent insanitary or unhealthful conditions or those which will interfere with the exercise of such public functions as fire fighting, street cleaning, sewering, etc.

Under this classification the residence by-street and the main thoroughfare are two extremes between which lie an unlimited variety of gradations: residence streets through which a little traffic passes to a by-street; minor feeders to main thoroughfares, which might be called secondary thoroughfares; retail business streets con-

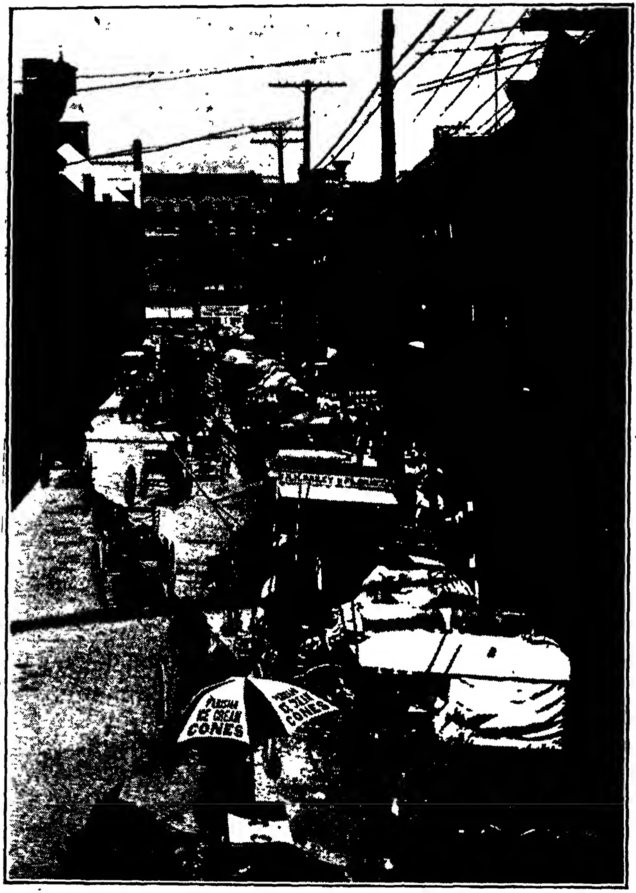


FIG. 6.—A MARKET STREET.

necting main business thoroughfares through which traffic circulates, etc. In methods of treatment and of paying for improvements these would logically share to a greater or less extent the features of both by-streets and thoroughfares, in proportion as they more nearly approximate the one or the other in traffic conditions.

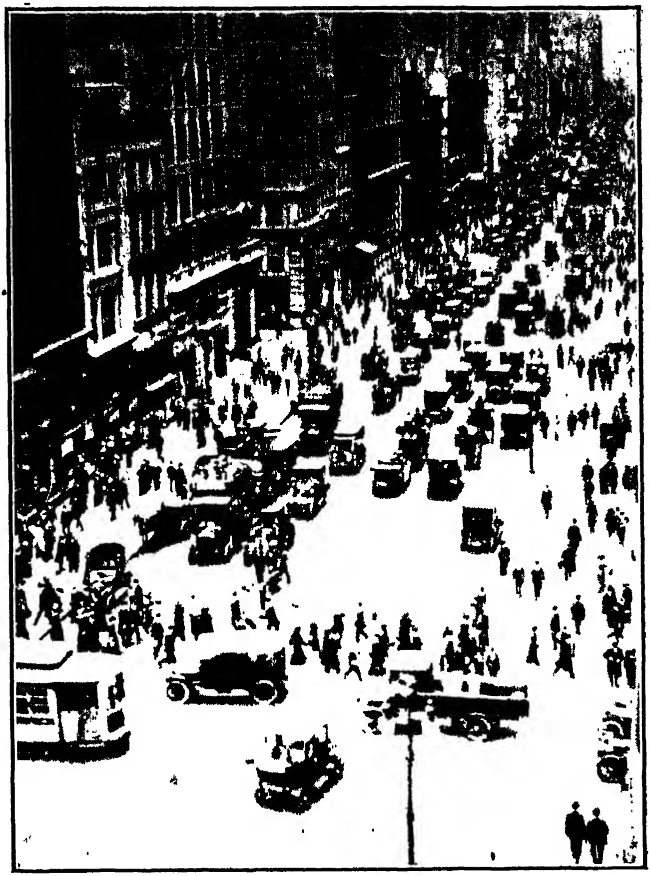
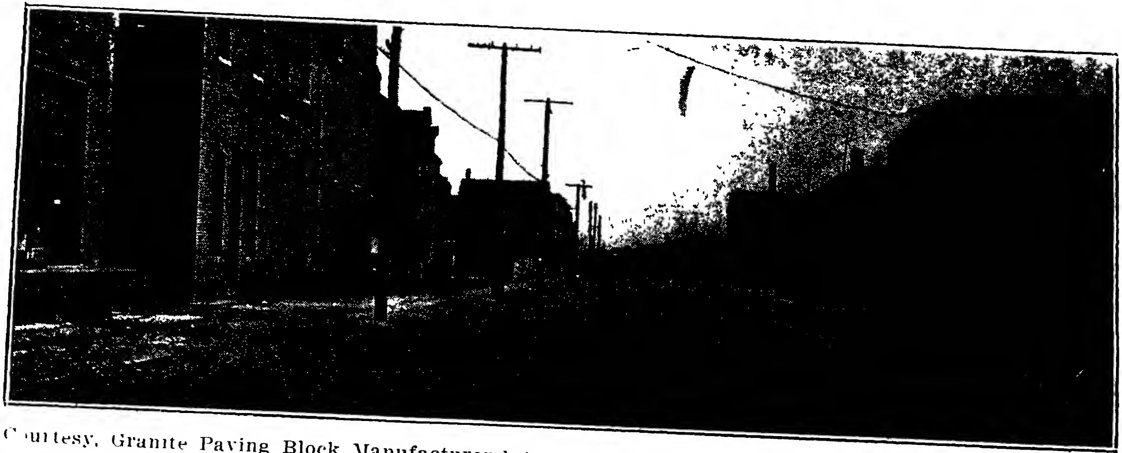


FIG. 7—A MAIN TRAFFIC THOROFARE



Courtesy, Granite Paving Block Manufacturers' Association.

FIG. 8—WAREHOUSES AND STABLES RENDER SIDEWALKS ALMOST USELESS.

A method of assessing cost on abutting property which we have previously recommended is to charge against a given street what would be the cost of its improvements if it were a purely local street, whether residence, business, manufacturing, etc.; any cost above this, incurred because of through traffic, to be paid by the city at large because it is for the benefit of others than the abutters.

There are public ways which some would not call streets, provided for special purposes. Alleys are narrow ways (generally 20 feet or less in width) giving access for vehicles to the rear of lots and fronted by no buildings except stables, garages and the like. Lanes, for foot traffic only, usually for short-cuts where the grade is too steep or sufficient width of right of way can not be obtained for wheel traffic. Venice, Cal., has streets of customary width but with foot walks and lawns only, no teams being allowed on them. Speedways are provided by a few large cities for fast vehicle travel only. And other instances of special public highways are found in different cities.

In addition to classification according to traffic carried, another and the second most important classification is according to the use of the abutting property. The most general divisions are business and residence. The latter may be subdivided more or less definitely into residences of the wealthy, the well-to-do, and the poor; the former into retail shopping, wholesale, warehouse and freight, market, office, mill, etc.

As an illustration of a practical application of this analyzing of functions to street construction, a warehouse street may be cited. The chief use of such a street is to transfer heavy goods between the abutting buildings and trucks, and this requires that trucks back up directly to loading platforms or the building line. This requires that the pavement on the sidewalk space be such as to carry vehicles without damage and that curbs be omitted; and it interferes seriously with the use of the sidewalks by pedestrians. Such pedestrians as there are for the most part use the street, not to reach these buildings, but as a thoroughfare, and in do-

ing so are compelled to walk in the roadway. We can see no reason, except the thoughtless following in old ruts, why the roadway pavement should not be carried to the building line and the sidewalk (or rather the foot-walk) be located in the middle of the street. All uses of the street would thus be better served.

The above considerations show wide variations in nature of uses to which streets are put, and in amount of traffic using them. A by-street may be visited by only ten or fifteen teams a day and twice that number of pedestrians—some by less than this; main thoroughfares may be traversed by a thousand times this number (actual counts in New York have given 300,000 pedestrians and 40,000 vehicles passing one corner in a day); and yet some cities have cast-iron rules that no street will be accepted as a public street which has not a certain standard width of roadway with a standard sidewalk (a common standard is 36-foot roadway and 12-foot sidewalks). Such a rule would seem to be absurd— n the many cases where less width is required by traffic; inadequate in others where the street is used as a main thoroughfare; giving a stiff, monotonous appearance to the city, and preventing attractive park-like treatment of high-class residence sections. A little intelligent consideration of the requirements of each street, forethought and foresight in planning, and appreciation of the importance of the subject, could not, it would seem, fail to result in a street system adapted to securing greater convenience, economy of money and of effort, pleasure, safety and health than has been the rule in the past in most cities and continues to be in many of them.

It is with a view to encouraging such logical and effective treatment of streets and discussing some, at least, of the methods to be employed in securing the desired results, and data and illustrations of practice upon which to base them, that this book has been written.

CHAPTER II.

PLANNING STREET ALIGNMENT

The alignment of a thorofare is all-important, for such a street is used by numbers of citizens as a means of getting from one point to another; but that of a by-street is much less so, for its most important features are its contribution to the health, comfort and pleasure of a few residents, and where it leads, or how, is of minor importance. Hence the planning of the alignment of thorofares should precede that of the minor streets. When it is fixed, the minor streets can be adapted to it.

The two most important considerations in thorofare planning are adjustment to traffic and economy. Economy in pavement construction, repair and maintenance are familiar ideas to all, but economy in street lay-out is apparently overlooked in most cases.

ECONOMY IN STREET PLANNING.

The economy referred to is that involved in apportioning the area to be devoted to street surface and in the utilization of the land. Assume two cities, one having 30 per cent of its area in streets and 70 per cent in occupied land; the other having 50 per cent in each; and both having the same shape. Then, to hold the same population on lots of the same size, the latter city must have an area 40 per cent greater than the other, and any dimensions of the larger area will be about 18 per cent greater than corresponding ones of the smaller area. Therefore, the thorofares (and other streets as well) must be 18 per cent longer, and cost 18 per cent more with the greater, than with the smaller percentage of

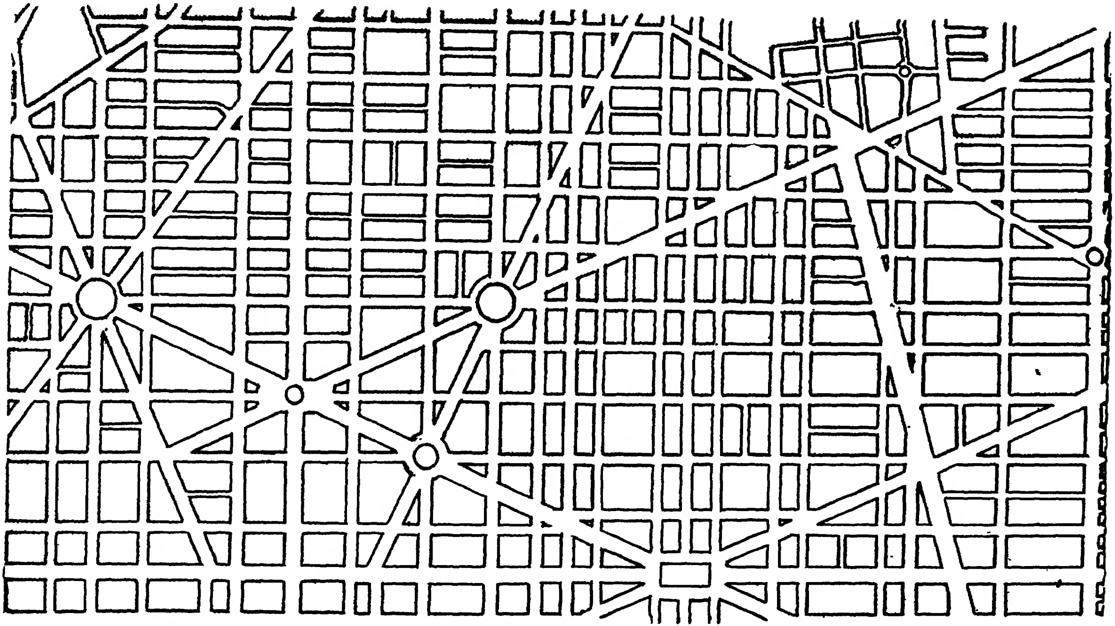


FIG. 9—PART OF WASHINGTON, D. C., SHOWING DIAGONAL STREETS.
Forty-three per cent of the area of Washington is occupied by streets, and an additional amount by parks and "circles."

As to price secured for the land, there is a similar difference. It is evident that, assuming building lots are worth the same amount per square foot in each city, a given amount of total area (which was once all private property) will yield only five-sevenths as much in one case as in the other. But the assumption will not hold if the saving in street area is carried to an extreme, for if the streets are too far apart to permit of dividing into lots of advantageous size, or to give adequate access to all parts of the area, or if they are so narrow that traffic is congested and sufficient light and air can not reach the lower stories of buildings, then the price obtainable per square foot will be much less than under more favorable street arrangement. Just what the ratio between street area and lot area should be, in each class of city subdivisions, to produce maximum returns from sale of land is one of those subjects concerning which there appears to be little definite information.

The relative area occupied by streets is determined to some extent by the shape of the blocks which they surround. Geometry teaches that the length of street (or perimeter) to surround a given area is least for a circle, less for a regular polygon than for an irregular one, and increases as the number of sides decreases. But if we try to use circles and combine them in groups we find waste areas which, if included in the street area, would greatly increase this. The only regular figures which will not produce such waste areas are hexagons, squares and triangles. The first will give the least area of streets, but the hexagon does not lend itself readily to convenient subdivision into lots, and the streets will all be winding, straight ones being impossible. The triangle permits straight streets, but is uneconomical of space and is inconvenient for subdivision into lots as a universal form. Triangles can be used to advantage in some cases, however, as will be explained later.

Squares are nearly as economical of area as hexagons, give straight streets throughout and are most convenient for lot subdivision, and they (or rectangles, which may

be considered as modified squares) are the most common form of subdivision.

Given a group of circles with 250-ft. diameter and streets 60 feet wide, and the streets and waste areas will occupy 41 per cent of the total area. Circumscribe a hexagon around each circle, with 60-ft. streets, and the street area is reduced to 35 per cent. If we use squares having the same area as the circle, with 60-ft. streets, these will occupy 38 per cent of the total area. To calculate the percentage of the total area occupied by streets

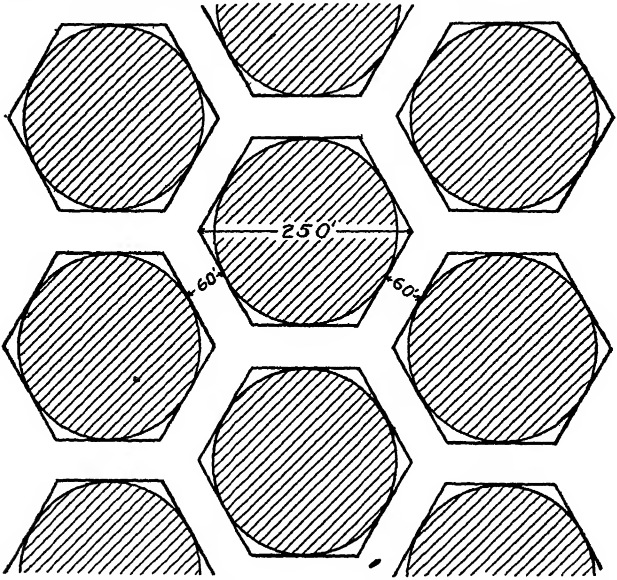


FIG. 10.—ARRANGEMENT OF CIRCULAR AND HEXAGONAL BLOCKS.

when all block sizes and street widths are uniform throughout the area considered; if we call *L* and *l* the dimensions of the block and *W* and *w* the corresponding street widths, then the percentage is $100\frac{(L+W)\ (l+w)-L\times l}{(L+W)\ (l+w)}$

In the illustration, the block is 250 by 400 ft. and the

streets 60 and 80 ft. wide, and the formula becomes $100 \dfrac{(330\times460)-(250\times400)}{330\times460}$ which gives 34.1 per cent.

A square having the same area would be 316.2 ft. on a side. If we take such a square with 60 ft. and 80 ft. streets, we have $100 \dfrac{(376.2\times396.2)-(316.2\times316.2)}{376.2\times396.2}$, giving 32.9 per cent. That is, if the city be laid out in rectangles

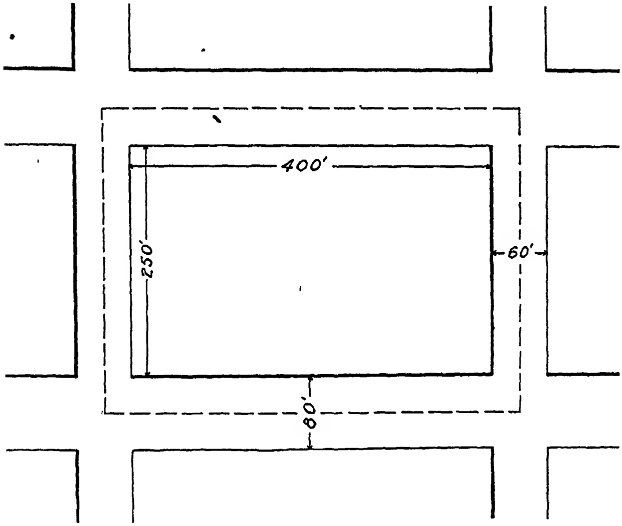


FIG. 11—TYPICAL BLOCK IN RESIDENCE DISTRICT.

of the dimensions shown, instead of squares of equivalent area, the street area will be 3.6 per cent greater $\left(\dfrac{(34.1-32.9)}{32.9}\right)$

The factor of economy of land area is one of the least important in planning streets, since when they are first planned the land is generally quite cheap compared with the value it will have as either street or building area

when the city has spread to and beyond it. Conservatism from this point of view would lie in assigning abundant land for street width, since it is easy to transfer part of it to private owners later if desired, but expensive and sometimes physically impossible to secure adequate additional width.

But the effect of prodigality of street area on *lengths* of streets is a more important factor in the problem. As seen above, an increase of street area from 30 per cent of the total to 50 per cent adds more than 18 per cent to the lengths of streets necessary to accommodate a given population, and 12 per cent to the average of all the distances to be traveled by all citizens in passing from all points of the area to the center. This means an addition of 18 per cent to the amounts spent on constructing street pavements, sidewalks and other items of street construction and to the cost of maintaining and cleaning these; and an ever-continuing addition of 12 per cent [illegible] ime and energy (whether muscular or gasoline) consumed by the citizens in passing between their homes and business, shopping or pleasure centers.

The area devoted to streets is determined by their width, length and number. The matter of width will be considered later. The length and number are fixed by the skeleton outline of alignment. The number of total streets of all kinds is fixed to a large extent by the sizes of blocks, which also will be considered later; but the number of main thorofares is primarily a matter of traffic demands, modified by consideration of safety, health and economy.

As to length, since "a straight line is the shortest distance between two points," straightness is desirable in thorofares, and gives a minimum of pavement area. As regards the convenience to traffic, however, a straight line is not always the shortest distance, if time and energy consumed be the measure; for a detour around a hill or valley may require less of each than a straight course across it, especially if we consider the time required to haul a given tonnage and that the straight, hilly course would necessitate lighter loads and more of them. But even in such cases the grade can be kept low and still

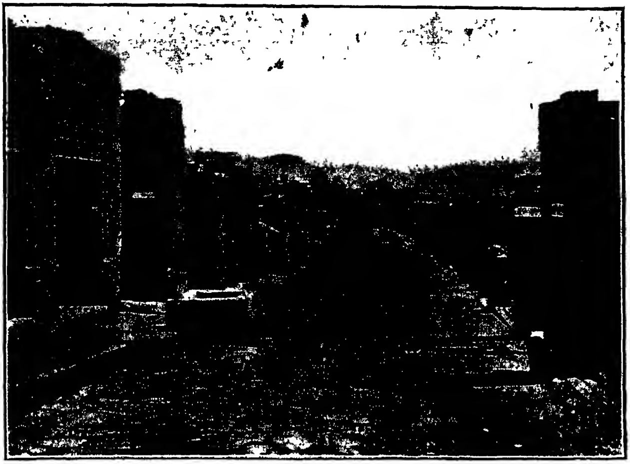


FIG. 12.—STRADA DEL ABBONDANZA, POMPEII.

FIG 13.—HIGH STREET, OXFORD

The illustration of High St, Oxford, shows the pleasing effect of a long sweeping curve. The similarity of this and the Pompeiian street is striking.

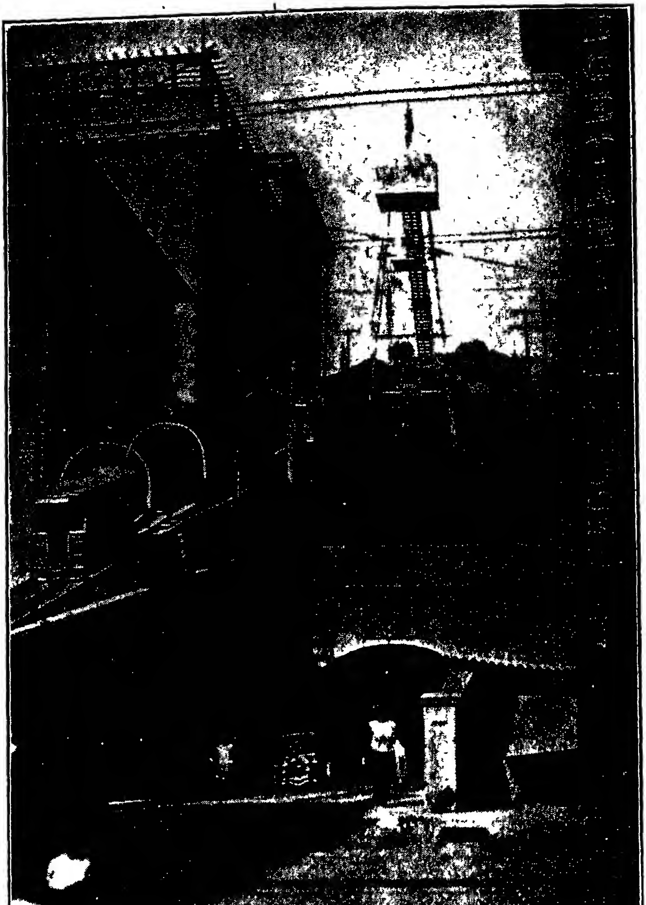


FIG. 14.—TUNNEL STREET IN LOS ANGELES.

Also street railway up steep surface of right of way.

the line can be made straight, if the traffic warrants the expense, by tunneling the hill or carrying a viaduct across the valley. Such tunnels have been constructed in Los Angeles, San Francisco and other cities and are under construction in Pittsburg; and viaducts are to be found in most large and many small cities in hilly country. On the west bank of the Hudson river, opposite New York, are several inclined viaducts for surmounting a steep, high hill. In Pittsburg are inclined railways for carrying both vehicles and pedestrians up steep hillsides. In New York a street tunnels to the center of a hill and pedestrians are there lifted to the summit in an elevator. This subject also will receive more extended discussion later.

From the above illustrations it appears that a straight alignment is possible under almost any conditions of topography; but these expedients for avoiding detours are not only expensive, but are not so pleasing to travel, and are of no service to the land along their course; and a detour of moderate extent is preferable for most reasons.

As to number of thorofares, considering traffic only, the greater the number the better. But here economy must step in to limit the number. The greater part of the traffic will wish to reach certain centers—a shopping center, manufacturing center, railroad or waterway freight station, etc.; while a bridge across a river, a valley-street between hills and other points determined by topography will be focusing points for traffic even more definitely fixed. The greatest convenience for traffic will be afforded by a number of streets radiating from such a point in all directions like spokes from a hub. Many large cities have such radiating streets, most of which probably were originally highways leading from adjacent villages or farming communities to the city in question. Most cities have at least four such streets, or rather two streets intersecting at right angles and extended both ways from the intersection. The advantages of adding additional radial streets and the treatment of them and of traffic centers will be discussed in the next chapter.

CHAPTER III.

DIAGONAL THOROFARES

A set of rules was adopted several years ago by the commission appointed to prepare a street plan for the District of Columbia outside of the city of Washington, which have not, we believe, since been improved upon for a residence city, outside the business center, in a district of low hills and generally irregular topography. The rules would apply to extensions of almost any city of more than 25,000 or 30,000 population, and in any but flat country. They are as follows:

"1. The avenues* should be extended with great directness to the District line, forming a fan-shaped system of highways to the city. This gives the essentials -web system.

"2. That on account of its simplicity the checkerboard or gridiron system should be located whenever maximum grades of six per cent shall (*would*) not be frequent or cause cuts and fills to exceed twenty feet.†

"3. That where direct extensions shall (*would*) be of undulating grade, curved highways are preferable, adding a picturesque feature to the system and relieving the monotony of straight lines.

"4. That curves of small radii should be avoided, and in very broken sections of narrow ridges or valleys it is preferred to follow the sides rather than the top or bottom of the hill.

"5. That the largest number of avenues should lead to or from the city, and cross avenues be infrequent and located on prominent ridges or on easy lines of communication.

*"Avenues" is used to indicate what we have called main thorofares.

†This would vary with the topography. The grade limit might be reduced to three or four per cent and the fill limit to eight or ten feet in a more level country.

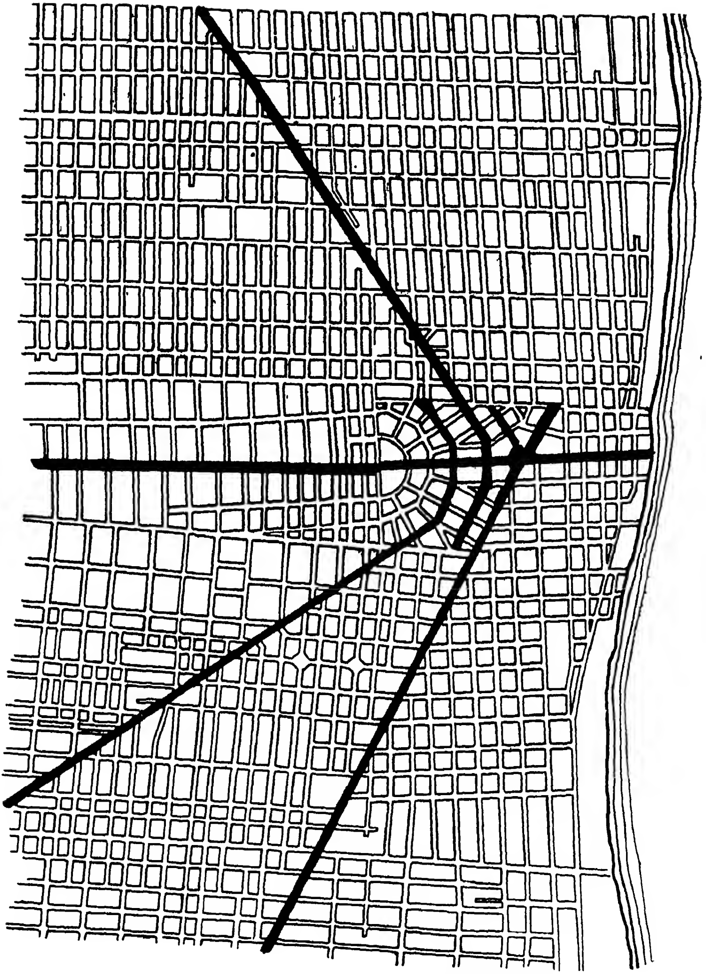


FIG. 15 – THE CENTER OF DETROIT, MICH.

"6. That small parks and circles which are such prominent features of the city plan be eliminated from the extended system and that large areas on prominent points of view be selected as parks and connected by avenues or curved drives."

The rule advising locating a street half way up a hill rather than in the bottom of the valley gives more sightly locations for houses, but fails to provide for sewerage and drainage. Sewers and drainage channels for surface water must, in most cases, occupy the bottom of a valley, especially one having steep sides; and if the street is placed midway of the hill, it is desirable to secure at least a narrow right of way through the valley for drainage purposes. Also, if the hill is fairly flat on top, a street on the summit is often desirable for the view it affords; but there should be another street in the valley to provide for sewerage and drainage.

Rules No. 1 and No. 5 especially apply to thorofares, calling for a number radiating from the business or other [illegible] and the greater necessity for [illegible] these than for those approximately perpendicular to them. In most cases, however, general traffic will be sufficiently accommodated by thorofares each 45° of angle around the center, which may be illustrated as follows:

Given a city laid out in rectangular blocks 560 by 250 feet (see Fig. 16) with streets 60 feet wide, except the thorofares, which are 80 feet, and consider an area 6,100 feet square, with the center of traffic in the center. Insert the two diagonals between corners. Then the distance necessary to travel to reach the center from the corners is 29% less by the diagonals than by any other route, and by use of the diagonal may be reduced by a smaller amount for every point in the city except those within a block of one of the two original streets passing through the center.

If we now insert other radial streets intermediate between the original rectangular axes and the diagonals, the maximum increased saving in distance for any point is 7%. This saving might be worth the cost in some cities, but not in many.

In the original rectangular plan, the streets occupied 27% of the total area of the city. The diagonal streets will occupy but 2¾% additional area, to offset which, they furnish an additional 6% street frontage, all on thorofares and therefore above the average in value.

Another advantage of diagonals is that, within a given distance from the center, measured along the streets, we will have about 50% more frontage. Also if all the blocks which the diagonal thorofares cut across were withdrawn from use for building and made into parks, the remaining frontage which could be reached in a given time or with a given distance traveled would still be about 14% greater than without the diagonals; and it is not nearness "as a bird flies," but the distance to be

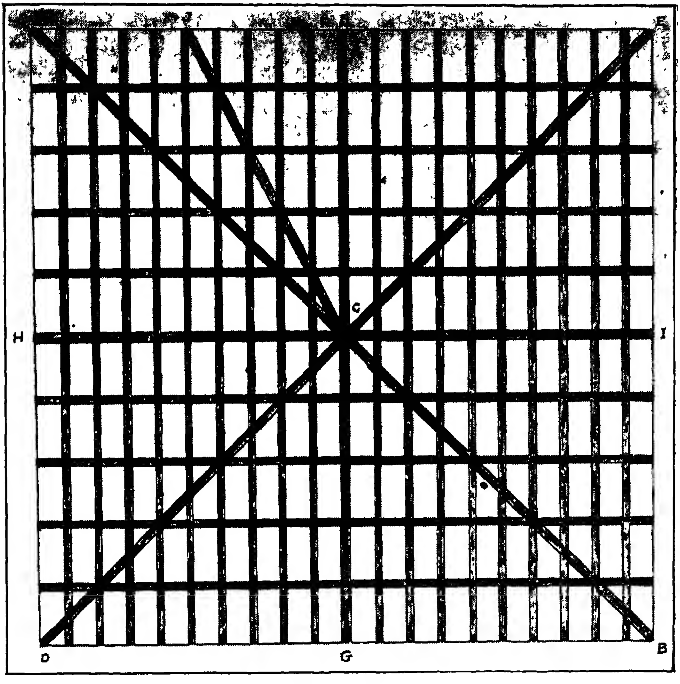


FIG. 16—DIAGRAM ILLUSTRATING USE OF DIAGONALS.

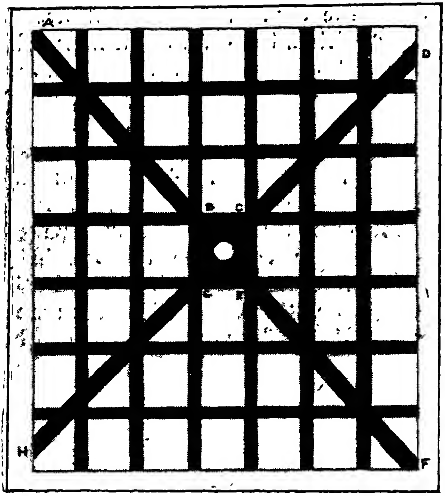


FIG. 17.—PUBLIC SQUARE AT CENTER

traveled to reach the "center of things" which determines land values and density of population and of business. Diagonals therefore tend to relieve congestion of business and of residents.

The above discussion shows the geometrically theoretical advantage of the diagonal. It assumes a flat plain where grades are negligible; that no streams, lakes or other natural features affect the problem; that the center of attraction is at a given corner rather than a district, or that it is desirable to have it so. Practically, there will be all sorts of modifications made necessary or desirable by local conditions.

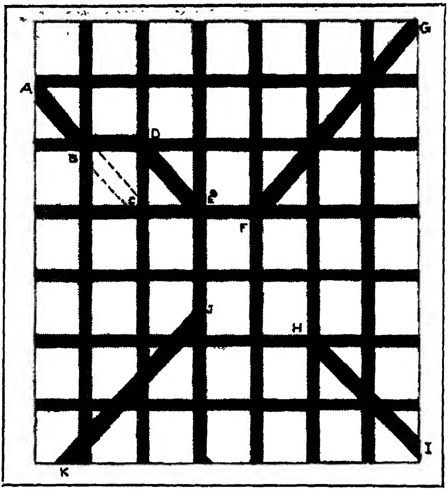


FIG. 18.—NON-SYMMETRICAL DIAGONALS.

A straight line on the plan is not necessarily the shortest distance between two points, if time and energy required to travel the distance be the measure. It may be that a detour around a hill will furnish a thorofare which can be traveled in less time and with larger loads than a straight one over it.

Where there is

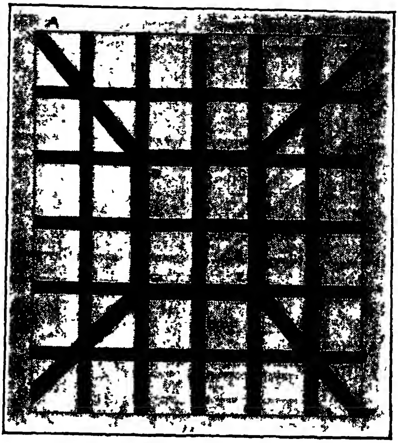


FIG. 19.—SQUARE "RING" STREET

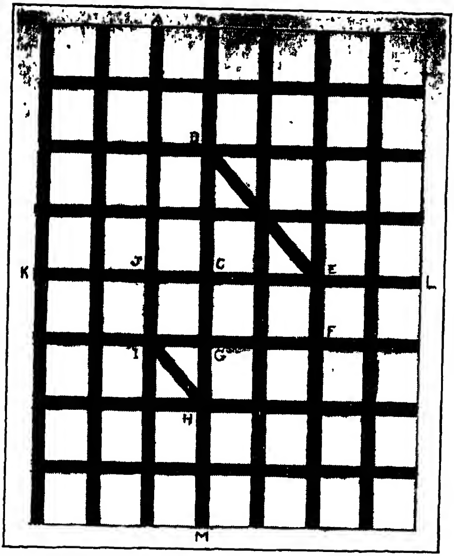


FIG. 20.—DECONCENTRATION AT CENTER.

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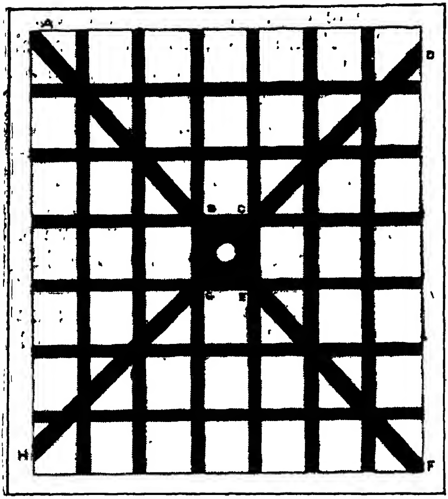
to require eight thorofares, it is certainly undesirable to have them focus at one point, because of the congestion of traffic caused, and the cutting of all corners at the intersection into acute angles, where the land will be more valuable than any other in the city or at least in the section of which this is a center.



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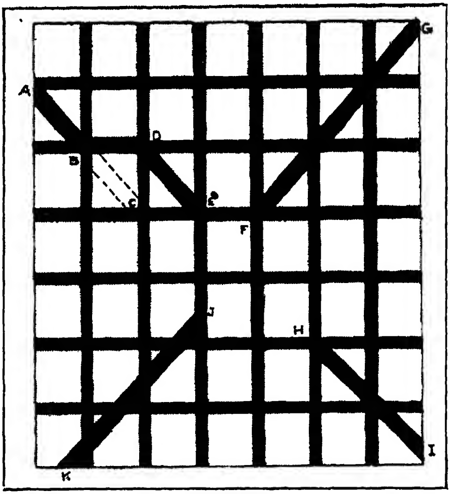


FIG. 18 —NON-SYMMETRICAL DIAGONALS.

A straight line on the plan is not necessarily the shortest distance between two points, if time and energy required to travel the distance be the measure. It may be that a detour around a hill will furnish a thorofare which can be traveled in less time and with larger loads than a straight one over it.

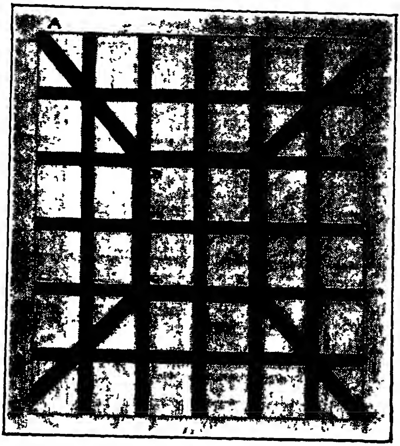


FIG. 19.—SQUARE "RING" STREET

Where there is sufficient traffic to require eight thorofares, it is certainly undesirable to have them focus at one point, because of the congestion of traffic caused, and the cutting of all corners at the intersection into acute angles, where the land will be more valuable than any other in the city or at least in the section of which this is a center.

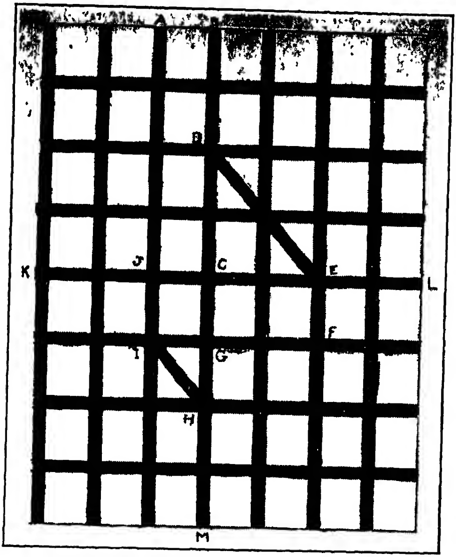


FIG. 20.—DECONCENTRATION AT CENTER.

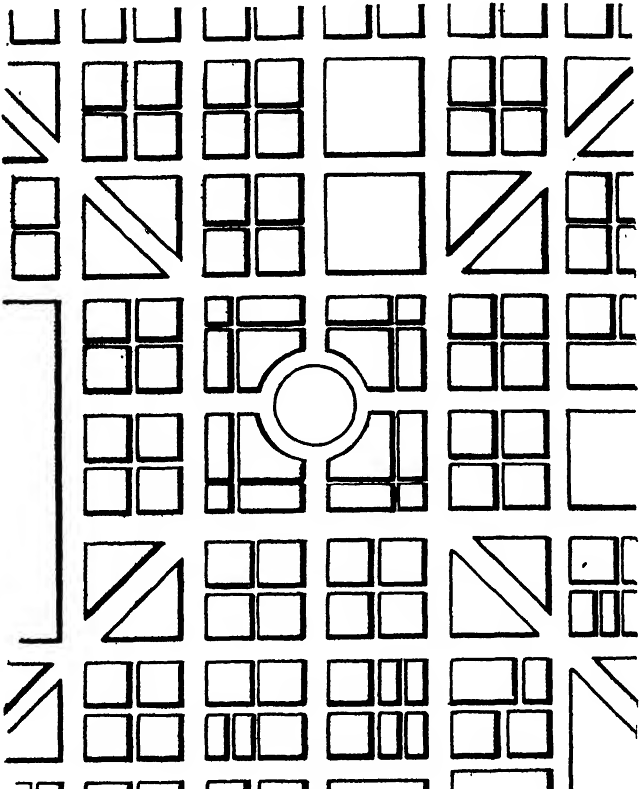


FIG 21.—THE CENTER OF INDIANAPOLIS, IND.

If the diagonal is being located after the city is built up, the property at the very center is probably more valuable than that a block or two away; and the cost of the property purchased or condemned for the diagonal street will be less if such street start a little distance from the center, as in Fig. 18. Also a jog in the diagonal as shown in the same illustration will sometimes permit dodging a valuable building, a knoll or other obstruction and the value of the diagonal suffer but little in effective-

FIG. 22.—THE OLDER PART OF PHILADELPHIA, PA.

Fig. 22 shows the older part of Philadelphia, which was laid out on the rectangular system and extended for several blocks north and south of the Public Buildings at A. It has been extended since, modified by diagonals which were roads leading to neighboring settlements. The desirability of other diagonals has become felt and two are proposed N.E. and N.W. from A. Existing ones from B and D (the latter focusing at river bridges) are among the city's most crowded thorofares.

ness thereby, although a double turn in the line of a thorofare is objectionable.

Having concentrated the traffic at the business district it may be very desirable to prevent the concentration proceeding further, and even to cause it to scatter.

In some cases the diagonals terminate at a "ring"

street (shown as a square in Fig. 19, but in some cities made as an irregular circle or polygon), which is treated in width and other features as a main thorofare. Still another plan is to leave a large open square at the intersection, often surrounded by public or semi-public buildings (Fig. 17); and the center of this offers an unequaled location for a monument or other ornamental structure. In such a case the traffic should be made to move counter-clock-wise when crossing the square at any point. Instances are often found where two intersecting thorofares cause such a congestion of traffic, that diagonals may be useful to deconcentrate rather than to concentrate. (See Fig. 20.)

The idea of the diagonal to give short cuts can be applied at numerous points besides business centers. The end of a bridge may well be the starting point for one or two diagonals, the emergence of a main thorofare from a narrow valley onto a plain, and other points where traffic from a large area is compelled to concentrate at one point.

CHAPTER IV.

DIAGONAL THOROFARES

(CONTINUED).

Congestion of traffic may be occasioned not only at focusing points or centers of concentration, but also at junctions and crossings—in fact, wherever lines of heavy traffic meet or cross each other.

Fig. 23 shows a junction of two diagonals with a third street at a common point, the lines and arrows showing routes of traffic, both vehicular and pedestrian. (There may be two or more lines of vehicles traveling one route and represented by one line.) This shows 16 crossings of vehicle traffic routes. If we separate the junctions of the diagonals with the vertical street, however (see Fig. 25), we have only three crossings at each junction, or six altogether; less than half the traffic crossings found in the first case, and less than one-fifth of this number at any one corner.

The second plan increases the distance to be traveled in passing from one diagonal to another, and Fig. 27 shows how this can be remedied. Such cross-overs are indeed even more desirable where the two junctions come together as in Fig. 23, for they would remove from this junction point most of the traffic passing from one diagonal to the other, or eight of the sixteen traffic intersections. From the single junctions they would remove two intersections from each, leaving only one at each of the two staggered intersections, as compared with eight at the combined intersection.

At an oblique crossing (Fig. 24) there are eight traffic route crossings, and three at each of two oblique junctions of parallel streets with a third (Fig. 26). With a square intersection there are sixteen route crossings, as

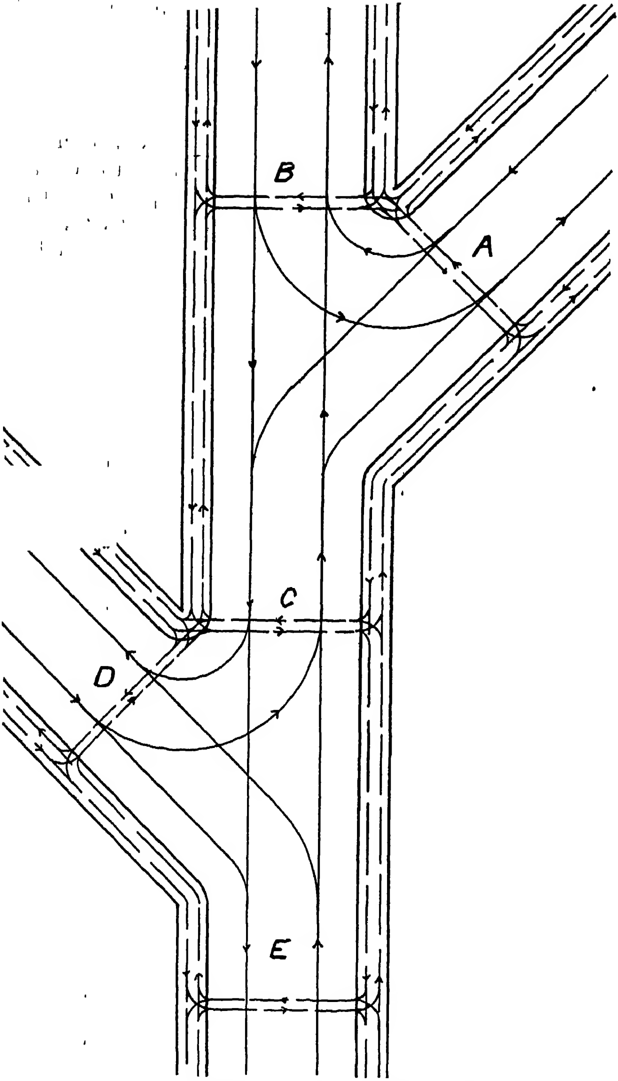


FIG. 25.—STAGGERED JUNCTIONS.

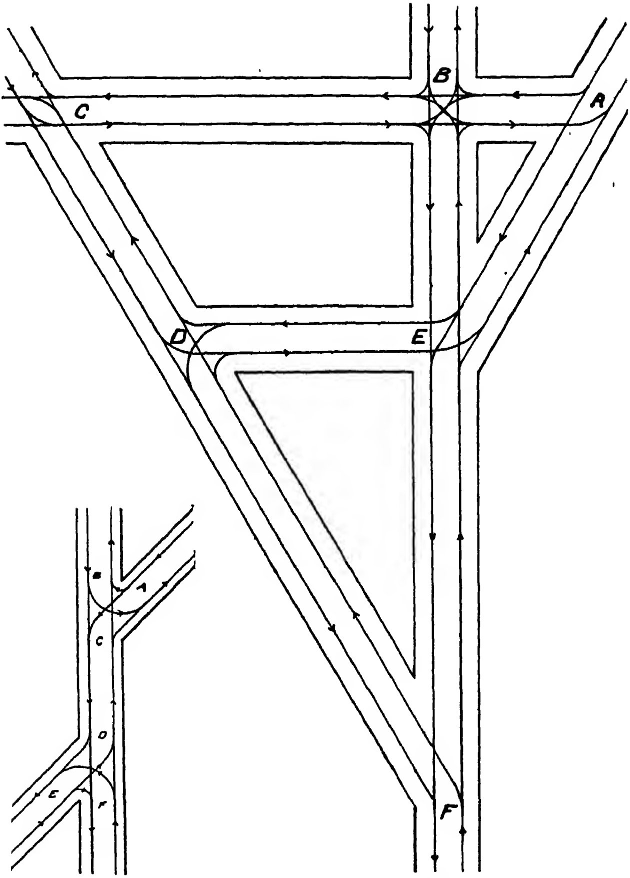


FIG. 26.
STAGGERED
CROSSING.

FIG. 27.
CROSS-OVERS BETWEEN
DIAGONALS.

tion should be paid to obtaining flat grades in the case of thorofares leading to center of freight traffic or districts where heavy articles are manufactured than of those leading to retail business centers. Such a double system is shown in Fig. 28, which, while imaginary, can be found

reproduced more or less closely in several cities. A bridge crosses the river at **a**; at **c** is the business center marked by an open square. At **k** is a manufacturing center, receiving freight by river at the foot of the street opposite **k**, and by the railroad **al** at the freight station **l**. From **c** we have as radiating thorofares **a c**, **cd**, **e j**, **c i**, and **b h**; while **a g h** and **n b** divert the bridge traffic from the center to the right, and **a m** connects the bridge with the manufacturing center and the freight yards near **l** **d e f g** is a ring street around the business center, diverting from this to the right and left traffic passing from B or C to A, I, D or H. Communication between the radial thorofares and from sections B and C to the manufacturing center **k** and sections F and G is furnished by the cross thorofare **i j k**; while the thorofares leading up and to the left from **k** connect this center with the residence sections E and F.

In some cities there are no diagonals and the cost of cutting them through built-up property seems prohibitive. But the discussion given herewith shows how desirable they are, and they should be provided in all plans where this is possible, the greatest pains being taken in locating them to forsee future traffic conditions and requirements so far as this is possible, and to provide for them with the least present inconvenience and expense. The failure to do so may later prove to be a serious handicap to the city. Several cities have spent hundreds of thousands in remedying such omissions, and scores of others would provide one or more diagonals urgently needed by traffic if the cost were not so enormous of purchasing and destroying expensive buildings standing on the proposed route. (See Fig. 30.)

As stated, a straight thorofare is generally desirable; but a more or less winding diagonal, laid out so as to avoid very expensive buildings, is much to be preferred to none at all. In a number of cities it is possible to even improve conditions as to structures by so running a diagonal as to wipe out "eye sores," "fire traps," and other relics of an outgrown business infancy which are worse than valueless as a municipal asset. Even if the need of diagonals is not yet felt, experience shows that

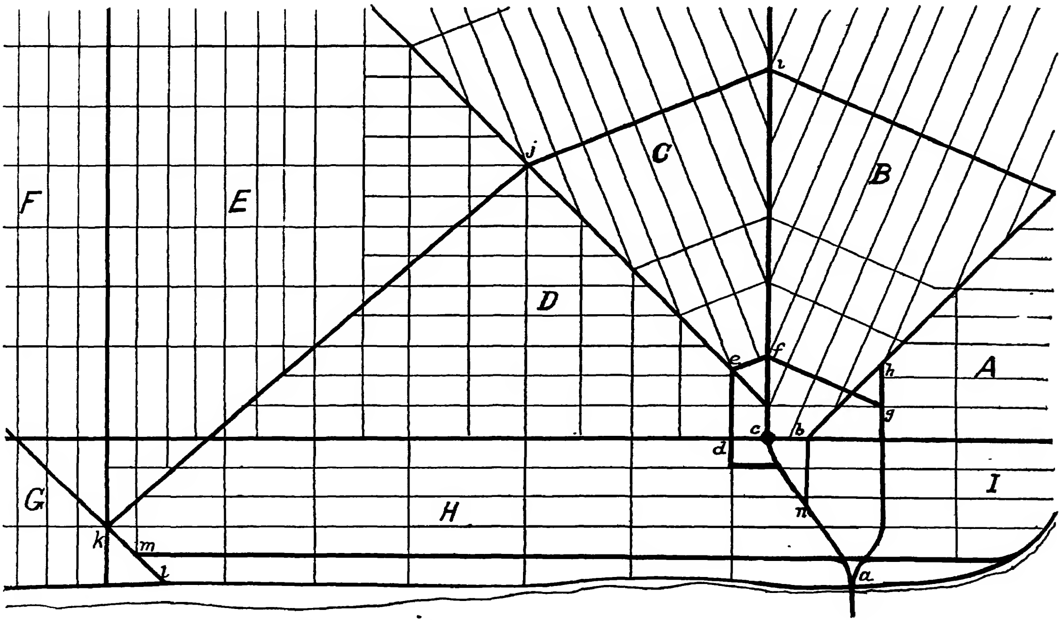
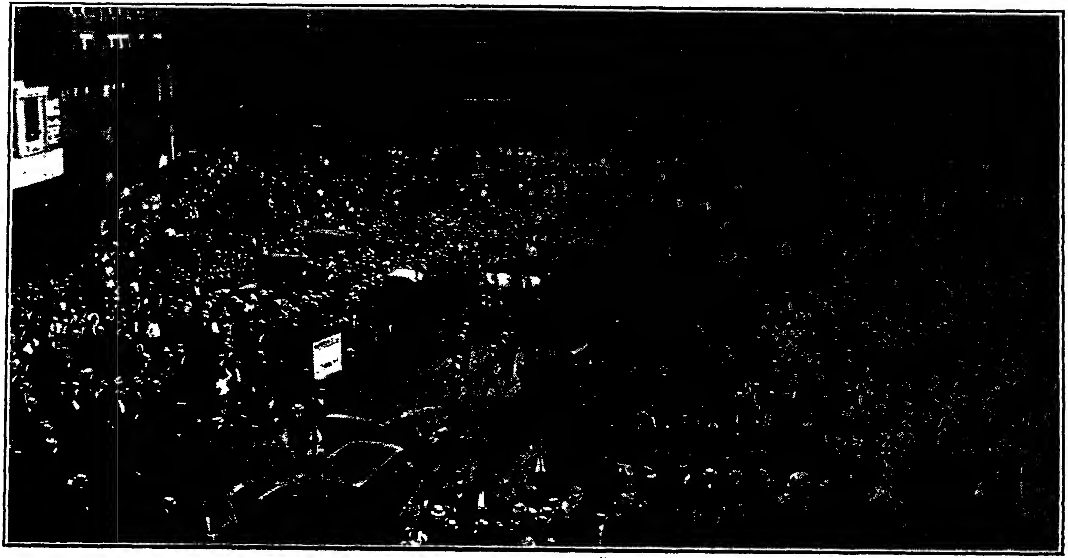


FIG 28 — TWO TRAFFIC CENTERS, AFFECTED AREAS OVERLAPPING.



Courtesy, C. N. Green, Engineer, New York Public Service Commission.

FIG 29—PEDESTRIANS CROSSING ROADWAY AT ACUTE ANGLE JUNCTION.

it will be in the future if the city grows, and no city will admit that it does not expect to grow, or a village that it will not some day be the center of a city.

Whether there are only the two intersecting thorofares which determine the business center, or are also one or more diagonals, the traffic may become so great on any one or more of them as to be undesirably congested. This can, as said before, be met by widening the street or providing more thorofares; the latter being preferable. The additional thorofares will generally be those streets parallel and immediately next to the original main thorofares. Consequently these streets should from the first be laid out with the idea of being so used later on. (An

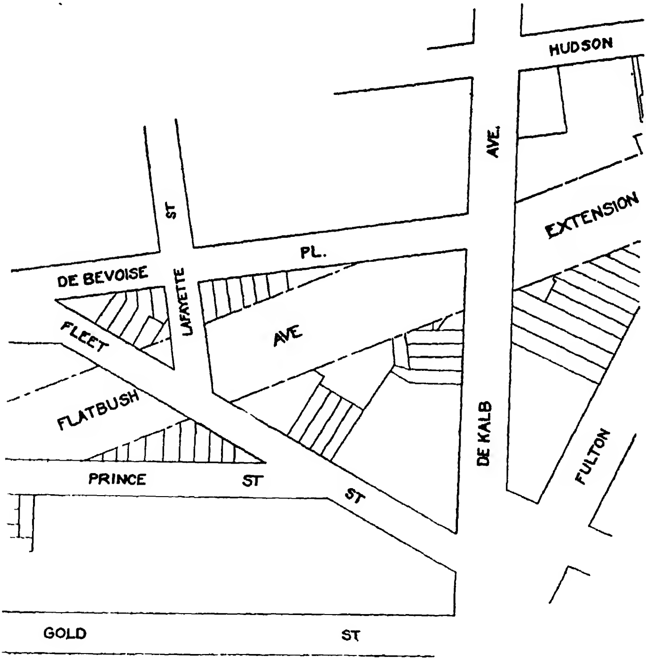


FIG. 30. CONFUSION OF PROPERTY LINES CAUSED BY NEW STREET

illustration of this duplication of thorofares in Atlanta, Ga., was described January 13, 1916, issue of Municipal Journal.) They should preferably be as near as practicable to the main thorofare; and in fact, as stated in the District of Columbia rules, streets parallel to radii from the center should be closer together than those crossing them; that is, blocks should have their longer dimensions along radial or approximately radial lines, or in general parallel to the lines of greatest traffic. Failure to observe this rule in planning New York (Manhattan Island) above 8th street is costing the city millions of dollars. The blocks are longer east and west than north and south, although much the greatest traffic moves in the latter direction. As a result, the fourteen streets provided for north and south traffic are crowded, especially the one diagonal, Broadway. If the blocks had been turned the other way but given the same dimensions there would have been thirty-nine streets to carry this traffic, thus greatly relieving it without increasing the total street area at all. Moreover, the frontage on these streets, which is more valuable than that on the cross streets, would be increased nearly three-fold, thus keeping down inflated values for such frontage. How frequent the cross streets should be will be considered under the subject of sizes of blocks; but the streets leading in the direction of the greatest volume of traffic should generally be as close together as will permit of economical and desirable depths of abutting lots.

CHAPTER V.

DIAGONAL THOROFARES

(CONTINUED.)

In the two previous chapters the advantage of diagonals was discussed from a mathematical standpoint. Additional advantages are that the addition of diagonals, by doubling the number of main thorofares leading to the center, alleviates or prevents congestion along the thorofares (but may increase it at the center, as already discussed.)

Diagonals increase the amount of light and air admitted to the business district, where the crowding of tall buildings and congregating of people make this especially desirable.

Among the objectionable features of diagonals, that of inconvenience and danger to pedestrians was shown in the

FIG. 31. HERALD BUILDING, NEW YORK
Paved area, small park and statue in angle between streets

Courtesy, Granite Paving Block Manufacturers' Association.

FIG 32—ACUTE ANGLE AT MONTCLAIR, N. J. DRUG STORE ON CORNER.

last chapter. Perhaps the objection, among those advanced, that seems most weighty at first thought, next to the cost of the additional street area, is the formation of oblique angled building lots at the intersection; but this is seldom serious in practice, as the following consideration will show.

Acute angles will often bring even higher rental per square foot than other corner property, being adapted to stores for the sale of articles not bulky and in popular demand, such as cigars, newspapers, drugs, groceries, liquor, etc., and they have more frontage per square foot of area than a rectangular corner lot. They also furnish excellent locations for small parks. By cutting across the angle, a building front can be obtained of any width desired, facing obliquely down the street and having an unusually good view of it and standing prominently in view from it. The small triangular plot cut off by such a construction may be used for shubbery, a fountain or other ornamental feature as an additional attraction.

Several such methods of treatment are illustrated in the accompanying sketches and photographs The Flatiron building in New York and the corners in Muskegon, Danville, Paris and Montclair show acute angles more or

FIG. 33. PLACE ST. AUGUSTIN, PARIS CATHEDRAL.

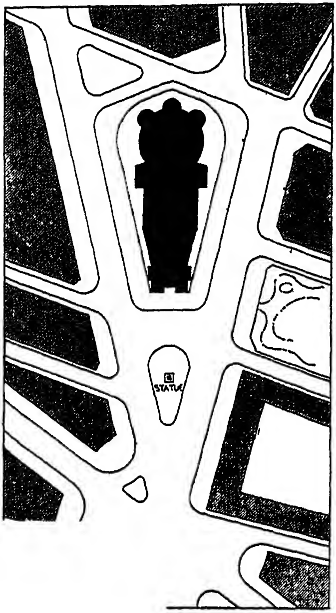
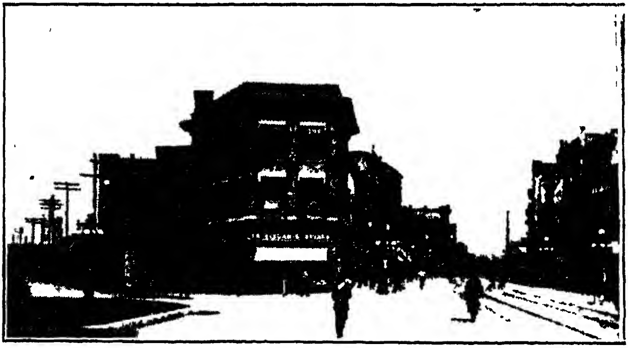


FIG 34.—PLACE ST. AUGUSTIN, PARIS. PLAN.

less flattened at the angle, while an obtuse angle (the Fifth Avenue building) is seen at the right of the Flatiron building.

In residence sections, such a corner furnishes an excellent location for a more or less imposing house, with the angle utilized for flowers shrubbery and other ornamental features. It is also a favorable location for churches; while the small drug store, corner grocery, cigar store and news stand, "poor man's club" and other places of retail trade which are found scattered at intervals throughout every residence section find in



Courtesy Barber Asphalt Paving Co.
FIG 35.—ACUTE ANGLE IN MUSKEGON, MICH. Corner Cigar Store.

FIG. 36.—OBLIQUE ANGLES IN NEW YORK

Flatiron building, filling an acute angle. At the right, the Fifth Avenue building filling an obtuse angle.

the angle at the junction of two thorofares their most favorable location.

In some cases the corner of an acute angle is cut back and rounded to facilitate the turning of the corner by vehicles. When the traffic is at all heavy this is not desirable, but it is better to provide a cross street between the

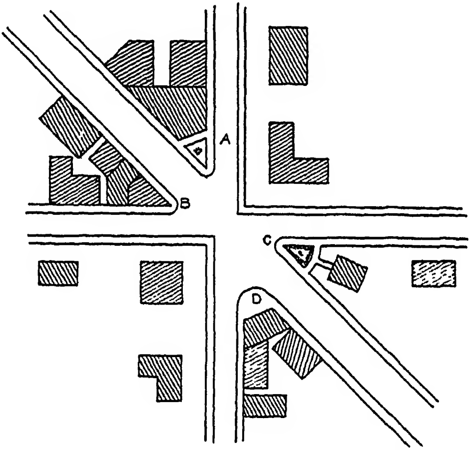


FIG. 37.—TREATMENT OF OBLIQUE CORNERS.

thorofares a short distance from their intersection and encourage traffic to use this, rather than add to the congestion at the junction, by leaving the angle sharp and awkward to pass around. (See Chapter IV.)

The application of the principles outlined in the preceding articles to problems encountered in practice will be considered in the next chapter.

CHAPTER VI.

PLANNING THOROFARES

While in the previous chapters special attention has been paid to diagonal thorofares, this has been principally because of the fact that they are not always or perhaps generally found in the average city planning, while streets of the rectangular system adapted for use as thorofares are to be found almost universally in this country. Certain of the streets of the rectangular system should be selected, however, to serve as thorofares in connection with the diagonals or in the absence of them.

In stating the general principles of laying out thorofares or selecting streets to serve as such, minute details as to exact locations were not given nor is it practicable to do so, since every city is a problem by itself and the proper solution will differ in almost every case. In fact, this idea that no two correct solutions are likely

FIG. 38. UNDESIRABLE WIGGLE IN STREET NOT REQUIRED BY TOPOGRAPHY

to be the same, but each must be solved entirely on the basis of local topographical and other conditions might be cited as another and very important principle. However, a few suggestions can be given as to how to apply the principles to particular cases.

Placing a street line upon a map and calling it a thorofare does not make it one, but the street must also be given appropriate width, grade, pavement and possibly other treatment necessary to attract or facilitate traffic. Perhaps the greatest fault of street planning in most American cities has been the idea apparently entertained that every street should be so designed that it may be used as a thorofare by any who wish to do so. There are several objections to this practice, some of the most important being that some one or two streets are likely to be best adapted for this purpose; streets not situated favorably to act as thorofares but better adapted for [illegible] ets are not, by this procedure, prop- [illegible] serve in this latter capacity and remain [illegible]ver misfits; and the expense of constructing *all* streets to carry through traffic is much greater than that of correctly selecting a few streets and adapting them for this purpose. In general, whatever any individual street is actually used for, whether as a residence street or a thorofare, it is a makeshift and fails of maximum effectiveness.

The aim should be to provide in the street lay-out a sufficient number of streets to carry the through traffic for an indefinite number of years ahead, but to develop for *immediate* use as thorofares only those which are needed at present, bringing the others into use from time to time as required.

If there are diagonal thorofares, these will almost invariably carry through traffic to an extent limited only by the territory tributary to such diagonal thorofare and the capacity of the thorofare. We do not recall ever having seen a diagonal which was not used more intensively for traffic than any other streets in the vicinity. Diagonals therefore will generally be used as thorofares from the beginning.

Ordinarily also two intersecting streets of the rectangular system will from the first have been recognized as the logical routes for through traffic. For a city of small or medium size—say up to 30,000 to 50,000 population—two main streets of the rectangular system and a diagonal or two will probably be the only thorofares required for each traffic center. It should be recognized, however, that these will probably become more or less congested as the city grows and the business conducted at the traffic center increases, and provisions should be made for other parallel streets to carry the overflow

FIG. 39. ROAD WINDING UP ORANGE MT., WEST ORANGE, N. J.

Court. Barber Asphalt Paving Co.

FIG. 40. ROADWAY WINDING UP HILL, FOOTWAY BY STEPS AT THE LEFT. MONTREAL, CANADA.

traffic. It is hardly practicable to provide parallels to the diagonals; but it should be assured that there will be streets parallel or approximately parallel to the rectangular thorofares and but a short distance from them (generally the next street on one or both sides of such thorofare), which will give continuous traffic routes only slightly if at all less direct than the original thorofare. In the case of a city already laid out, if such streets do not exist the earliest opportunity should be taken to provide such routes, utilizing existing streets so far as possible. This can generally be attained by connecting non-continuous streets through an intervening block here and there or connecting streets approximately continuous by short sections of new street. It is even possible to run such a connecting link through the first floor of a large building or row of high buildings on each side of a block, creating a so-called "arcade" for pedestrians and roadway for vehicles also, and thus reducing the cost of property taken. In some cases a special solution is possible, such as covering a small stream with a continuous roof and using this as a street, as was done in the "Fallsway" in Baltimore. In many cases a narrow street or even an alley can be widened to serve as a thorofare.

How many such parallel routes should be provided cannot be exactly foreseen. There are no data on the matter of relation between street traffic and population so far as we know; but observation of ourselves and others seem to indicate that in any given city which retains its general character (for instance as a commercial city, a manufacturing city, etc.), the amount of traffic to be handled will increase more rapidly than the population—possibly as the 3/2 or second power of the population. The number of thorofares leading in any one direction will of course depend upon the extent of growth in that direction and the nature of such growth. If the thorofare leads towards a hilly section, there is every probability that such section will be used for residences almost exclusively, and provision should be made for lines of surface cars or omnibuses, touring cars and pedestrians. Where part of the land is hilly and part is flat there is every probability that the latter will be

used for business, manufacturing, freight stations, etc., and the traffic provided for in connection therewith should be that of trucking and other heavy hauling. Streets leading to residence sections of the poorer classes will not probably require much roadway space for touring cars, but space for two street railway tracks should be provided and abundant sidewalk space. On the other hand, if the residence section is occupied by the wealthier citizens it is probable that one thorofare carrying street railway tracks will be sufficient but that two or three more should be provided for automobiles.

In addition to the main thorofares, there should be secondary or tributary thorofares branching off from each at intervals. How short these intervals should be must be left to individual judgment based upon local conditions. Some would more or less arbitrarily fix three quarters of a mile as the interval between tributary thorofares. Probably limits of one-half mile and one mile might be used as minimum and maximum. It will seldom be necessary to provide a parallel for future duplication of these tributary thorofares, except where they serve in reality as main thorofares to serve a large territory.

Courtesy Barber Asphalt Paving Co.

FIG. 11. PLEASING BEND IN THOROFARE, MAIN STREET, OCONOMOWOC, WIS.

As stated previously, grade is as important as alignment in thorofares and may be even more so. When a thorofare has been paved with the most modern smooth, non-yielding surface, the tractive resistance per ton on a level will probably vary between 16 and 20 pounds. A 1 per cent grade will offer a resistance of an additional 20 pounds, or will double the tractive resistance, and each additional percentage of grade will add an additional 20 pounds to such resistance. Where ordinary macadam is the pavement, the resistance due to the macadam may run from 50 to 100 pounds, and the tractive force required therefore is not doubled until the grade reaches 5 per cent. From this it appears that grade becomes more important as the pavement is improved, which will usually occur as the extent of the traffic increases and justifies the expense of such improved pavement. A few years ago, when the better grades of smooth pavement as they are found today were infrequent, a grade of 2 or 3 or even 5 per cent was not considered a serious obstacle to traffic. With present-day roadways, however, and automobile traffic in which the theoretical effects of grade apply or at least are observed to apply more exactly, every increase or decrease in grade becomes a matter for serious consideration. Light passenger automobiles will ordinarily make a detour which may even double the length of their route rather than climb an 8 to 10 per cent grade of considerable length, assuming that the roundabout road is equally advantageous as to width and character of roadway and contains no short turns. When it comes to heavy hauling by truck or otherwise, grade becomes an even more important matter. Here it may well be that the load carried must be reduced if grades are to be encountered, and a 3 or 4 per cent grade may make necessary such reductions in load or speed or both as to render it more economical to use a level road of double the length.

In providing for trucking traffic, and to a less extent for light passenger traffic, certain limiting grades should be decided upon for each thorofare and adhered to, either in immediate construction or as a possibility for further development. What these limiting grades will

be depends upon the topography of the country. In some sections no thorofare should be permitted to have a grade higher than 2 per cent, while in others, thorofares, even for light trucking, may be required having as high as 10 per cent. The latter, however, will probably never be used for hauling heavy freight or large manufactured products, and if more level roads cannot be obtained, this fact will prevent the development for manufacturing of a district tapped by such road. Where it is possible to reduce a grade to the desired limit by even quite considerable grading, it may be justifiable to so locate the route, with the idea that when the traffic demands it sufficiently, the grading will be done. This eventuality should be kept in mind in all plans involving such street, however.

On a level plane, street alignment may to a large extent be laid out with little attention to the topography, and in such case the formal rectangular system with the desired diagonals, all streets being straight, will probably be better than any other. Where the topography is irregular, however, there will be certain critical points and conditions which will to a large extent decide the layout of the thorofares. For instance, it may be that

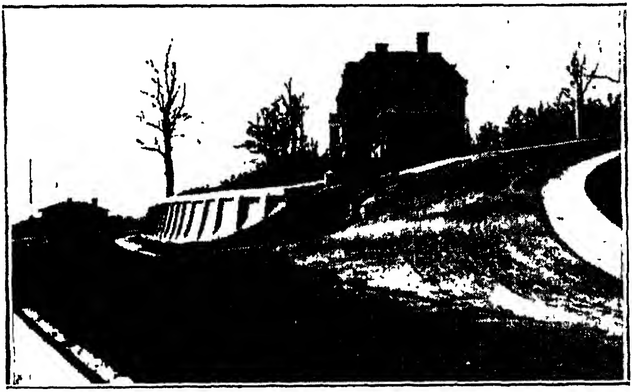


FIG 12 STREET WINDING UP HILL, WESTMOUNT, CANADA. RETAINING WALL FOOTWAY BY STEPS AT END OF WALL (BARELY VISIBLE)

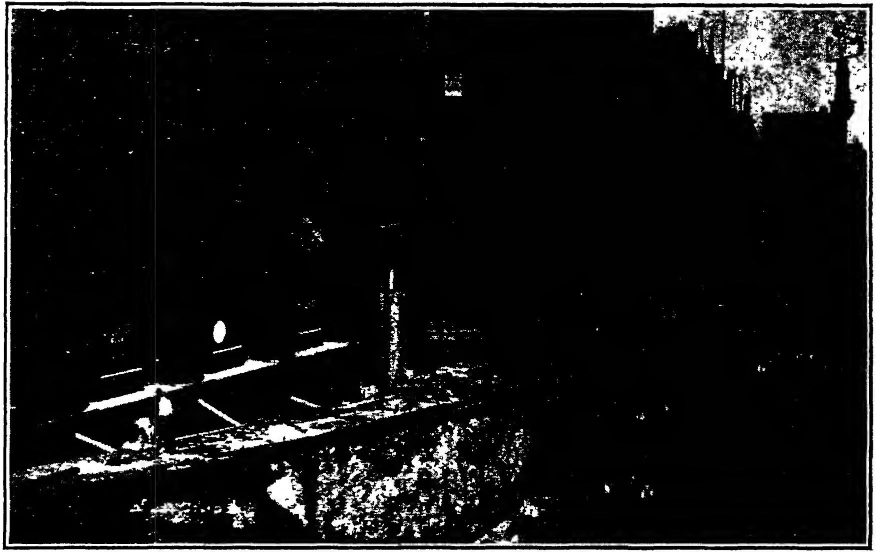


FIG. 43—LOWERING GRADE OF FIFTH AVENUE, "THE HUMP," PITTSBURGH. The buildings shown were erected with a view to such grading in the near future, as is seen in Fig. *44*.

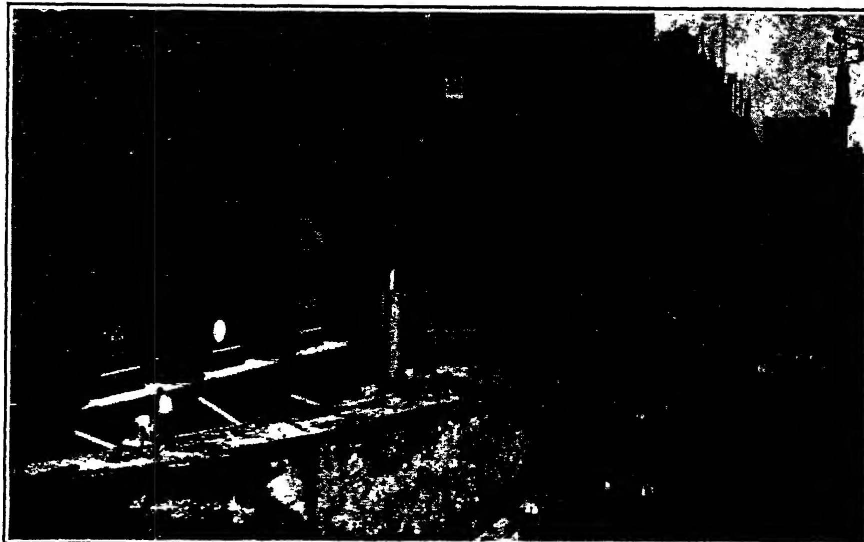


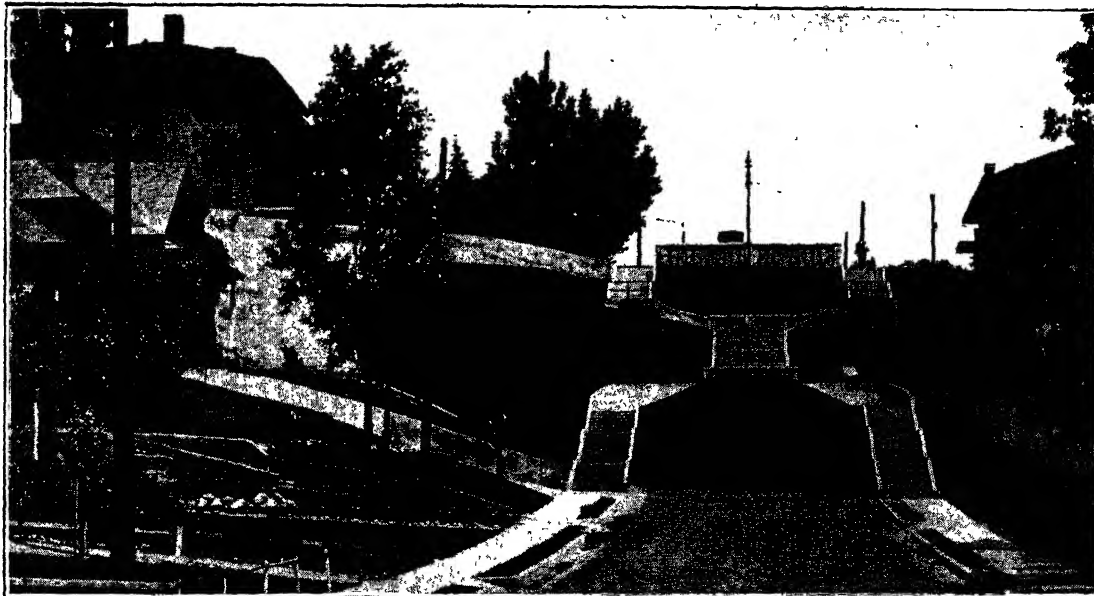
FIG. 43.—LOWERING GRADE OF FIFTH AVENUE, "THE HUMP," PITTSBURGH.
The buildings shown were erected with a view to such grading in the near future, as is seen in Fig. 44.

there are only two or three outlets from a restricted business center which do not necessitate hill climbing, in which case a special layout will be necessary, considering each outlet (generally the entrance to a valley) as a traffic center and making such provision that in the future abundant roadway and sidewalk width will be available through this valley. In some cases this has been secured, when the traffic has so increased as to demand it, by walling in and bridging over the stream flowing through the valley; this considerable increase in width being deferred until the expense is justified, the banks of the stream being meantime held as public property and utilized as narrow parkways. The time may come when even more direct and vastly more expensive thorofares may be demanded and secured by tunneling through the hill, either a comparatively level tunnel being used to give access to a flat area on the further side of the hill, or an inclined tunnel which emerges on a plateau at the top of the hill. An illustration is the Twin Peaks tunnel which San Francisco is now constructing at a cost of several million dollars and which will be more than two miles in length but which will connect with the city by a comparatively level route an area approximately equal to that on the near side of the hill tunneled.

Where the thorofares are needed to connect a low-lying business center with a residence section on the sides and top of a hill, it will generally be necessary to provide a winding thorofare or one rising diagonally across the face of the hill in order to secure reasonable grades. Here provision for future additional thorofares is more difficult, but it should be made, the topography being studied very carefully to determine the best location. The original thorofare will ordinarily be a long incline either rising continuously in one general direction across the face of the hill, or making one or more reversals of direction where opportunity offers. To provide for an additional thorofare, another can be started at the base of the hill a block or two from the first and carried up with approximately the same ruling grade; but in many cases a better plan is to have two or three

routes starting at nearly the same point (this being the point at the foot of the hill reached from the traffic center by the most direct route) but with different grades, one the flattest attainable, even at the expense of considerable length, for hauling coal, ice and other comparatively heavy loads required in residence sections; another steeper one suitable for touring cars and the like; and a third for light traffic which can make speed up steep grades and which would use the most direct though steepest route.

All curves should be made as flat as possible to reduce danger of collisions of vehicles; different authorities give from 300 to 1,000 feet as minimum radius, but sharper curves are often required in hill-climbing. Long, sweeping curves, especially when a reason for them is offered by the topography, are pleasing to the eye, but directness in main thoroughfares should not be sacrificed for this except where necessary. Double reversed curves, or wiggles, are displeasing to the eye, present additional danger to traffic because of temptation to short-cut across them, and should be avoided.



Courtesy, Sylvester Q. Cannon, City Engineer, Salt Lake City.

FIG 45.—CONCRETE STEPS FOR CARRYING PEDESTRIAN TRAFFIC UP A STEEP HILL. Fourth Avenue, Salt Lake City. Vehicles Can Ascend by Roadway at Left.

CHAPTER VII.

PLANNING THOROFARES

(CONTINUED.)

In the foregoing, vehicle traffic has been considered almost to the exclusion of pedestrian. One reason for this is that vehicle will largely exceed pedestrian traffic where the distances traveled exceed say one mile. For distances not exceeding this, however, pedestrian traffic should be borne in mind, and the fact that in many and perhaps the majority of cases pedestrians prefer a short though steep route to a roundabout one; consequently pedestrian thorofares should ordinarily be provided which are as direct as possible, even though such thorofares should be almost or quite impracticable for vehicles. In fact, in a number of such cases no provision whatever for vehicles is made, but the thorofare takes the form of a lane or a flight of steps; or such are used as short cuts between the loops of a winding roadway. One has only to visit the hillsides of almost any of our cities and towns to find illustrations of this. Where these have not been built up, there will be found paths worn across the vacant land by the daily passage of scores or hundreds of pedestrians, while in many cases steps of wood and sometimes of concrete or stone are provided for their accommodation. Lanes form an important and attractive feature of many European cities, and many are to be found in Boston and other of our older cities; but they have been almost entirely omitted in the newer cities in this country; and yet, where used they are found to be greatly appreciated by the citizens

bery or hedges along them they add a picturesqueness to the general street layout. Flights of steps are more common, but they are too often treated as though mere temporary make-shifts, only crude wooden steps being provided and not kept in repair.

Having provided a sufficient number of routes for both present and future thorofares leading in all directions, the treatment of these as they approach within a few blocks of the traffic center should not be overlooked, but here ways for dispersing the traffic from each one of the routes around the center (where congestion is likely to occur) should be provided for by short diagonals or other contrivances for persuading traffic which does not wish to go *to* but whose aim is to pass *through* the traffic center, to make a detour around it instead. This can be effected both by presenting slight obstructions to traffic just outside of the business centers, and also by introducing short cuts at these points from each group of thorofares to those leading in other directions. Methods of accomplishing this by "ring" streets or their equivalent have already been referred to.

At the best there will, however, be more or less passing through the traffic center, and considerable thought can well be devoted to designing this center so as to provide for the circulation of traffic through it with the least congestion and confusion. For this purpose an open space with a large paved area which permits the passing of traffic in long sweeping curves from one thorofare to another is of great advantage. There will be certain more or less triangular areas which will lie outside of such traffic routes which can be utilized for parking automobiles, for monuments, drinking fountains, small parks, etc. (The matter of providing space for parking automobiles is becoming increasingly important and will be considered later.)

The problem of street layout presents itself generally in the form of readjustment of existing streets to reduce traffic congestion or meeting other unsatisfactory conditions, or in planning extension of existing cities. In many cases a satisfactory solution of the latter involves the securing of a new thorofare to the business cen-

ter through the old part of the city. In selecting such thorofare existing streets will of course be used so far as possible. If the new section lies at the corner of an original rectangular layout, a diagonal may well be provided to serve it; but this need not start at the center, where it would have to be cut out of valuable property by razing expensive buildings, but will be practically as serviceable if started several blocks from it. In fact,

FIG 46—LANE IN MONTCLAIR, N. J.

there is advantage in bringing it only to the edge of the business district and thence following an existing main thorofare into and through such district; this reduces traffic congestion (as previously explained), saves largely in the cost of the new construction and especially of purchasing private property for right of way, and adds little to the distance to be traveled. For instance, if in Fig. 16 (page 29) an addition is to be laid out beyond A, the diagonal AC would save 29.3 per

cent of the distance to the center by the rectangular system; but if we start the diagonal four blocks to the left of C on the main thorofare CH, and run from there to A, the distance from A to C is 21.7 per cent shorter than by the rectangular systems; in other words, we save practically three-fourths as much distance as though we ran the diagonal straight to the center. If traffic in the thorofare CH would be congested by this, the diagonal could stop at the street just above CH, and this street from there to the center be used as a thorofare.

While it is generally advisable to reserve as public property all routes which will, for all time, be needed as thorofares, the advisability of purchasing built-up property for this purpose in anticipation of future needs is more questionable. In the first place, it is impossible to foresee exactly the developments of the future in growth of business and traffic, and it is possible that if the selection of location of a new thorofare be made now, it will not be as suitable to the needs of the future as if delayed until the need actually arises. For this reason, delay is worth risking an increase in cost of perhaps 10 per cent to even 50 per cent or more. Again, it is generally considered that the present generation should not be taxed too heavily for the benefit solely of a coming generation. Finally, the saving is not so great as it appears. We sometimes see such statements as: "If we had only looked ahead and bought this property thirty years ago we could have obtained it for one-third what it will cost now." But if the money had been placed in the bank at 4 per cent interest thirty years ago it would now be worth three and a quarter times as much, and the city has really saved money by waiting. In fifty years money at 4 per cent will increase sevenfold.

A practical continuous thorofare can often be made from non-continuous short streets, all leading in the general direction desired, by cutting off corners of blocks so that these short streets can be connected by long-radius reversed curves. This expedient can often be used where cutting through a new street would be impracticable.

CHAPTER VIII.

STREET PLANNING IN NEWARK

The following partial synopsis of that part of the Newark City Plan Commission's recent report which refers to street planning affords such an excellent illustration of the application in practice of several of the principles of street planning discussed in **Practical Street Construction,** that it is presented as a chapter. Note the addition of parallel thorofares and of a new diagonal, the connecting of non-continuous streets to give a continuous thorofare, and the layout of a new district.

There has just been published by the City Plan Commission of Newark, N. J., a report entitled "A Comprehensive Plan of Newark," which is the result of three and a half years' work of the commission, and may be considered as its final report so far as the general plan is concerned. The commission states, however, that "the plan by no means completes the work of the City Planning Commission. With the large amount of data now at hand supplemented with additional information from time to time, this commission can assist in a future revision of the plan, and if given certain authority to assist in its execution, can cover a large field of usefulness."

It is expected that the plan will receive in due course more or less revision, but will in time, it is hoped, be officially approved and adopted by the community through a referendum. If such a plan is followed, "every new step in the city's growth is as wisely taken as the limitations of human wisdom permit, and always toward comfort, utility and efficiency, while at the same time the harmony, dignity and beauty which follow wise adjustment

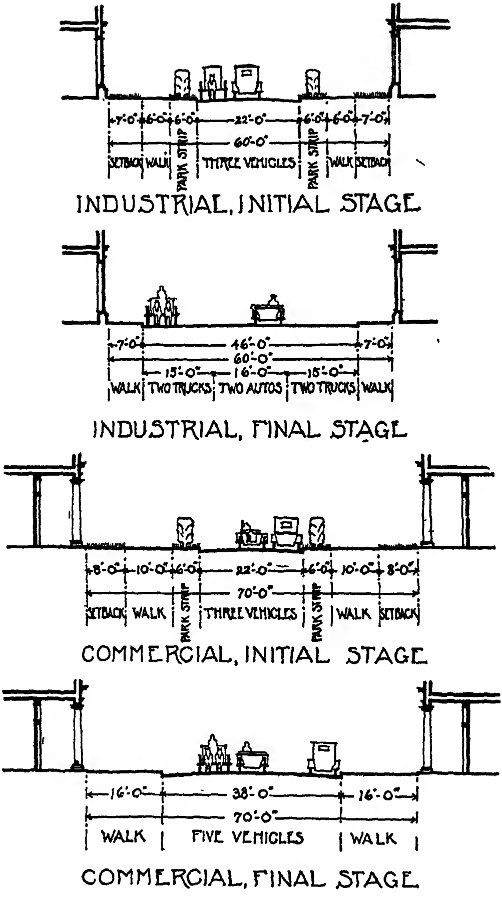


FIG 49.—STANDARD PLAN FOR STREETS IN COMMERCIAL AND INDUSTRIAL DISTRICTS.

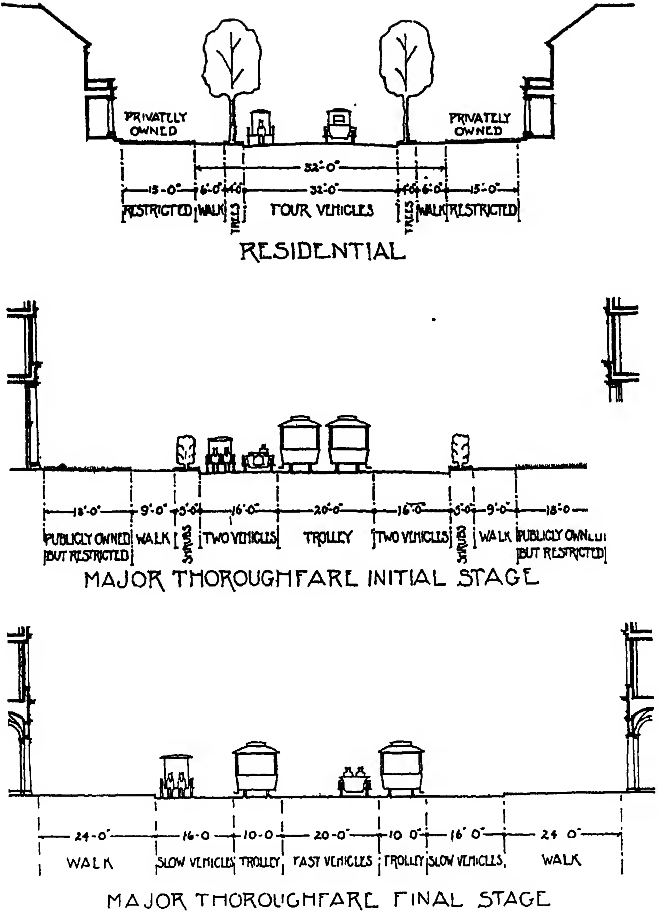


FIG. 50. STANDARD PLAN FOR MINOR RESIDENTIAL STREETS AND MAIN THOROFARES

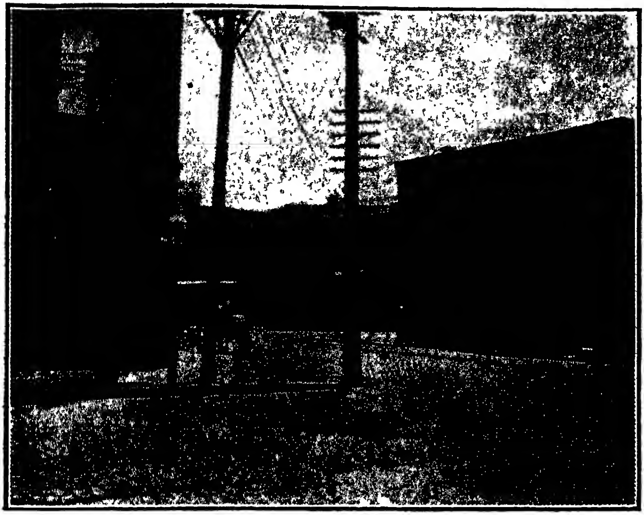
The report occupies 172 pages, with numerous illustrations, including maps and diagrams. While the greater part of it is of course devoted to local conditions, the general principles upon which the suggestions are based are of general interest. Certain of these, together with a few local applications which serve to illustrate them, are given below. The report is excellently gotten up and should be in the library of all who are making a study of city planning.

In general the city is well provided with diagonal thorofares leading to all of the adjacent communities to the north, west and south. To the east there lies nothing but the salt meadows between Newark and New York and these are traversed by a well paved highway.

The principal business thorofare of the city is Broad street, and although this is 132 feet wide, the commission lays great stress upon the importance of providing a means for relieving the crowding of traffic in this street. This it proposes to do by diverting part of the traffic into a parallel street known as Washington street. (Broad and Washington streets are indicated on the accompanying map by heavy lines); also by providing a diagonal from the angle in Broad street leading due south to the Market street depot of the Pennsylvania Railroad, thus providing a continuous thorofare parallel to the Passaic river, instead of requiring traffic to make a detour either through Broad street and Market street or others parallel to it, or else through other narrower and less well paved streets.

"In a previous report the cost of new streets was shown to be often excessive. It is difficult to divide streets into different classes and to fix specific rules for the development of each class; nevertheless a clear distinction can easily be drawn between streets which are used chiefly for residential purposes and those upon which is to be expected a large volume of traffic. The tendency in modern cities is now more than formerly to plan streets for the definite uses to which they are likely to be put, and to decide on the proper proportions of roadway and sidewalk in each case in accordance with established rules.

"A single vehicle needs about eight feet of roadway,



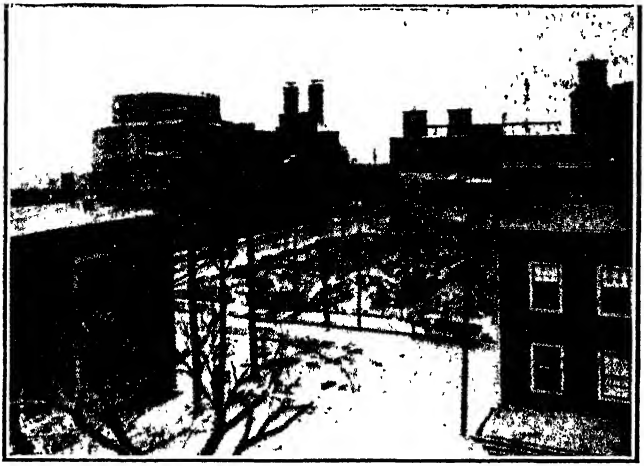


FIG 51—MAKING DISCONTINUOUS STREETS INTO A THOROFARE

Front street, Newark, as it was, and with straightening under way.

FIG. 52 BROAD AND MARKET STREETS—"THE FOUR CORNERS."

Taken during an hour of light traffic in the year 1912. Practically all the cars used in or entering

a trolley car, ten feet. By the use of these two units the width of roadway needed upon any given street can be determined, basing the decision on the number of lines of travel to be expected on it.

"Unless otherwise provided by ordinance, all streets in the city have sidewalks or footpaths one-fifth the width of the street on each side of the roadway. We suggest that in planning future streets they conform to a standard plan. All streets which may form part of the primary system of traffic thorofares should be 120 feet wide. All streets which will probably always be used only for residential purposes should be 52 feet wide, with building lines 82 feet apart, thus allowing for houses a setback of 15 feet. Herewith is shown a proposed standard form for new streets.

"Standard street plans are oftimes criticized because of lack of flexibility. The suggested plans should be adopted and followed, however, unless good reasons for departing from them can be given. We have built present streets with unsatisfactory results. To follow plans such as these, scientifically designed, means increased attractiveness, less cost for initial development, less cost of maintenance and greater effectiveness.

"*A Street Plan for the Meadow District.* The street plan for the new vacant meadow lands is of the utmost importance. The large tract owned by the city should be platted to form the nucleus of a plan for the entire district. A good street plan has been laid out for that part of the canal zone now being filled. Unfortunately, street openings on the meadows, outside the canal zone, have not all been made in accordance with a definite system. We find a tendency here toward haphazard planning. No further openings should be made save in accordance with an agreed scheme. Such a scheme is shown on the accompanying plan. In laying this out, attention has been given to the special demands of commercial, industrial and residential districts, also to the creation of a primary system of radial and rectangular highways, thus assuring proper circulation and distribution of traffic. The plan includes the entire meadow, for the development of this whole area should be harmonious, and the co-operation

in it of all interests should at once and earnestly be sought."

In connection with the studies of streets, traffic census records were taken at four points, about a half block each side of the traffic center of the city, the intersection of Broad and Market streets. Counts were taken in 1912 and

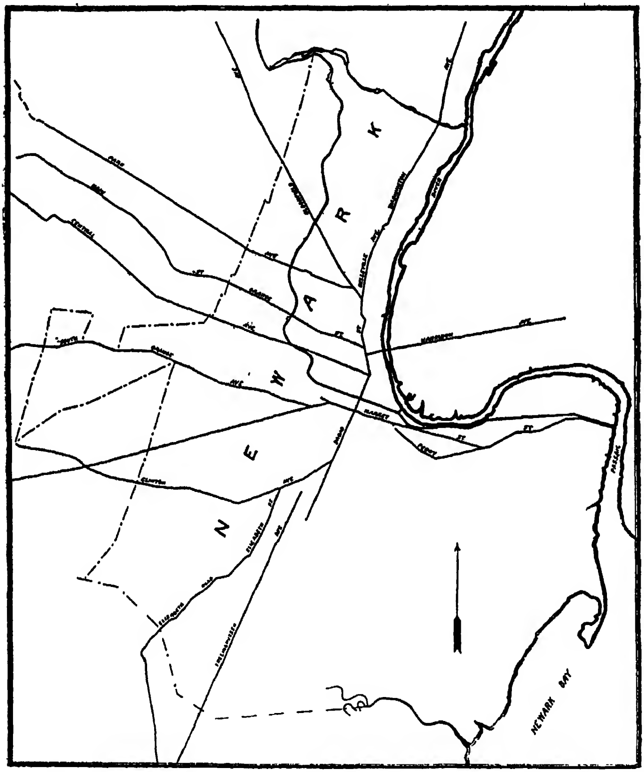


FIG. 53.—RADIAL THOROFARES FROM NEWARK'S BUSINESS CENTER.

Newark is the center of a Metropolitan District containing 700,000 people. The remarkable system of radial thorofares leading to the suburban districts is shown on the map. The beginnings of this system were made in 1705 by a special committee appointed in Town Meeting for this purpose.

again in 1915, and these show that there was an increase of 48 per cent in vehicular traffic at this point during these three years, but a decrease in trolley and pedestrian traffic due to the fact that the cars were rerouted to reduce the congestion at this corner, and the reduction in pedestrian traffic followed, largely as a result of this.

DAILY TRAFFIC AT FOUR CORNERS.

	Vehicles 1912	Vehicles 1915	Cars 1912	Cars 1915	Pedestrians 1912	Pedestrians 1915
Market, between Beaver and Broad.	2,277	3,636	1,955	1,697	68,253	41,550
Market, between Halsey and Broad.	3,252	2,261	1,517	1,664	77,036	72,556
Broad, between Mechanic and Market.	4,052	6,052	1,097	1,245	52,109	53,547
Broad, between Bank and Market..	4,210	5,974	1,536	1,255	82,493	72,071
	12,791	18,923	8,104	5,861	279,891	246,724
Per cent. of increase or Decrease	+47.99%		—3.98%		—11.85%	

TOTAL VEHICULAR TRAFFIC AT 107 OBSERVATION POINTS IN 1912 AND 1915.

	Iron Tires	Auto Trucks	Auto Mobiles	Rubber Tires	Street Cars	Total
1915..	69,471	15,322	72,463	7,342	43,483	208,081
1912..	79,823	5,065	34,016	10,338	38,755	167,997
Inc. or Dec...	10,352	10,257	38,447	2,996	4,728	40,084
P. C.	—12.97%	+202.51%	+113.03%	—28.89%	+12.20%	+23.04%

Concerning traffic, the report says: "The recent traffic census of Newark made by this commission shows an average increase of 20 per cent in the number of auto-trucks and an average increase of 113 per cent in the number of automobiles using the streets of the city in the short period of three years, 1912 to 1915. Yet, while the wheeled traffic throughout the city increased 23.8 per cent, that of horse-drawn pleasure and commercial vehicles decreased perceptibly—29 per cent and 13 per cent, respectively.

"Automobile licenses increased in number in New Jersey by 21 per cent from 1913 to 1914, and by 57 per cent from 1911 to 1914. Put these figures with those just

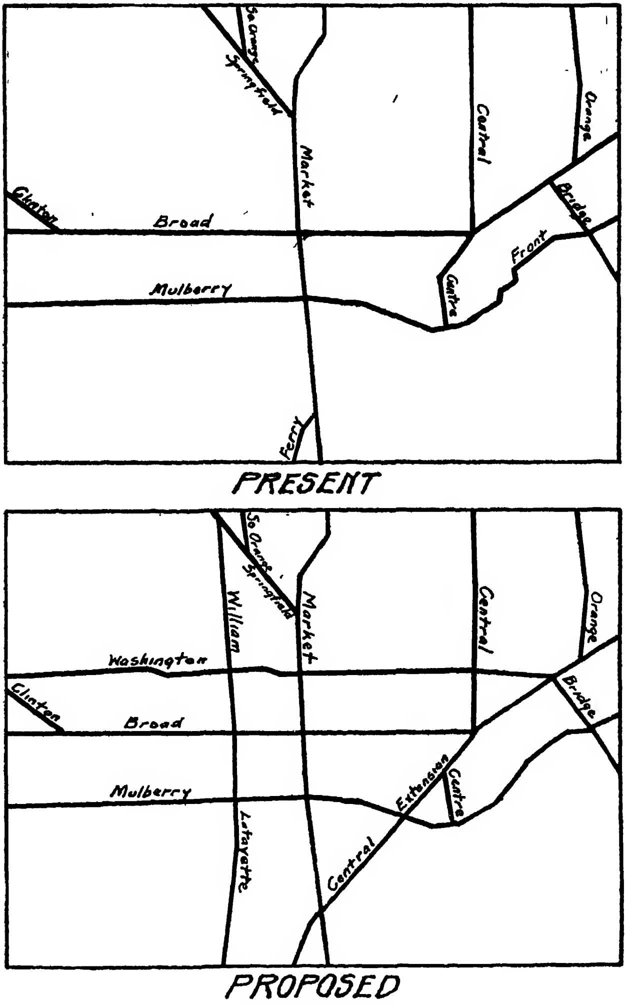


FIG 54—THROUGH TRAFFIC ROUTES, NEWARK BUSINESS DISTRICT.

given of the increase of wheeled traffic in three years, and it is evident that the number of motor cars on our streets will increase by at least 20 per cent per year for some time to come. The very fact that the new form of rapid transit tends to widen the residence area of a city will bring an increase in the number of those who come, from remote homes, to or through the center of the city."

Concerning amelioration of traffic conditions which can be brought about by regulation of traffic, the report says:

"The chief obstacles to traffic are the lack of proper parking facilities for automobiles and the constant interruptions to the direct and expeditious flow of travel. The following suggestions are offered:

No parking should be permitted in streets having a roadway width of less than 32 feet.

No parking should be permitted for longer than one-half hour in business streets.

Parking should be permitted on one side only of streets having roadway width of 32 to 40 feet.

No parking should be permitted within 300 feet of any prominent street intersection.

Left-hand turns should be prohibited at all important street intersections.

Regulation of pedestrian traffic at the Four Corners, crossings to be made only in the same direction and at the same time as vehicular traffic."

It also recommends that 12 streets be established as one-way traffic streets, 8 of which lead off of Broad street.

In addition to the consideration of street plans, the report also discusses transportation by street cars and other vehicles, by waterways, and railroads; also markets, parks, public buildings, appearance of streets and public places: while another section is devoted to housing, public control of the development to private property, land subdivisions, and metropolitan planning; and part four of the report discusses excess condemnation and suggests a chronological and financial program for the carrying out of the recommendations of the report.

CHAPTER IX.

STREET WIDTHS*

The question of practical street construction has to be considered from many standpoints. One of the first questions to be considered is the volume of traffic a street can be expected to carry in a satisfactory manner. Just as water pipes, gas mains, electric wires and other conductors are designed for the quantity of water, gas and electricity that they are to take care of, so should streets be designed for the traffic they may be expected to carry. Of course it is impossible to forecast the future in all cases, as the Dutch and English who laid out Broadway and other streets in lower Manhattan Island did not dream that the little settlement on the lower end of Manhattan Island would grow to be a city of over five million, and that Manhattan Island would increase in population until over two million people would live on the island, and other millions would flow daily to and from its multitude of business institutions to their homes in the surrounding cities and suburban towns for a distance of thirty to forty miles, and, in some instances, even greater distances.

As traffic has greatly increased during the past few years on the streets of the city of New York, it has become a very important problem. Streets that were designed for residence purposes have been transformed into business districts, built up solidly with loft and office buildings of great height, which daily house thousands of employees, and the handling of thousands of tons of package freight through narrow streets and loading and unloading it from wagons and trucks to and from the business houses has become a serious problem.

*This and the following chapter were written for Municipal Journal by H. C. Hutchins

DATA AS TO VEHICLE SPACE.

One of the greatest difficulties in properly handling traffic in congested districts is that caused by the position of standing vehicles. In 1912, several hundred actual measurements were taken of vehicles standing in different positions. These were classified in six groups as per diagram.

Position No. 1 gives the greatest amount of room for moving traffic in the street. The following table shows what the average amount of roadway space occupied by different types of vehicles measured:

No. of observations	Kind of vehicle	Average width of vehicle	Average extreme distance
9	1 horse truck	7′- 0⅜″	7′- 2¾″
21	2 horse truck	6′-10¾″	6′-11¾″
4	Automobile	6′- 6″	7′- 3⅜″
6	Auto truck	6′- 5⅝″	6′- 6⅞″
1	5 horse truck	7′- 6″	8′- 4″

The extra width due to load varies from 2″ to 18″.

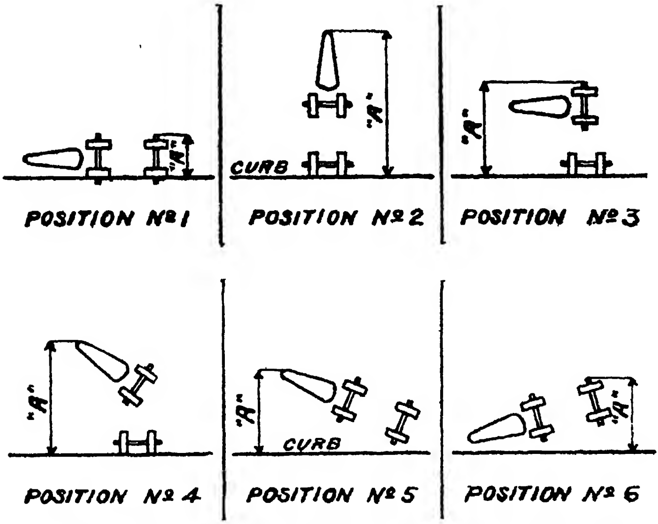


FIG. 55.—SPACE OCCUPIED BY VEHICLES STANDING AT CURB IN DIFFERENT POSITIONS.

The actual distance from the curb occupied by vehicles in this position varied from a minimum of 6′ 4″ to a maximum of 9′ 6″, with an average of 7′ 1 1/8″.

Position No. 2, with the vehicle and horse at right angles to the curb takes up the greatest amount of room for the street and is, therefore, extremely bad from a traffic standpoint. From the loading standpoint, however, it allows a greater number of vehicles to stand in front of any business house than any other method, and the loading can be done over the rear end of the wagon from a loading platform. Results obtained were as follows:

No. of observations	Kind of vehicle	Average width of vehicle	Average extreme distance
16	1 horse truck	6′- 3⅜″	16′- 9⅜″
6	2 horse truck	6′- 5⅝″	19′- 8⅛″
[illegible]	[illegible]les	6′- 4⅞″	14′- 3″
[illegible]	[illegible]cks	6′- 0⅜″	15′- 9⅜″

[illegible]ance from the curb occupied by vehicles [illegible] this position varied from a minimum of 12 ft. 3 in. to a maxiuum of 21 ft. 9 in., with an average of 17 ft. 8 in.

PositionNo. 3, where the vehicle stands at right angles to the curb line, with the horses turned so as to stand parallel with the curb. This position reduces the amount of street space taken up by the vehicle and horse together, and also increases the number of vehicles that can be placed at the curb line as compared with position No. 1, but does not permit as many as in position No. 2, owing to the length taken by the horses standing parallel with the curb. Results of measurements were as follows:

No. of observations	Kind of vehicle	Average width of vehicle	Average extreme distance
17	1 horse truck	6′-9¼″	10′-11⅜″
34	2 horse truck	7′-0⅞″	13′- 0⅜″
1	4 horse truck	7′-3″	12′- 3″

The actual distance from the curb utilized by vehicles in this position varied from a minimum of 8 ft. 9 in. to a

maximum of 16 ft. 2 in., with an average distance of 12 ft. 4⅛ in.

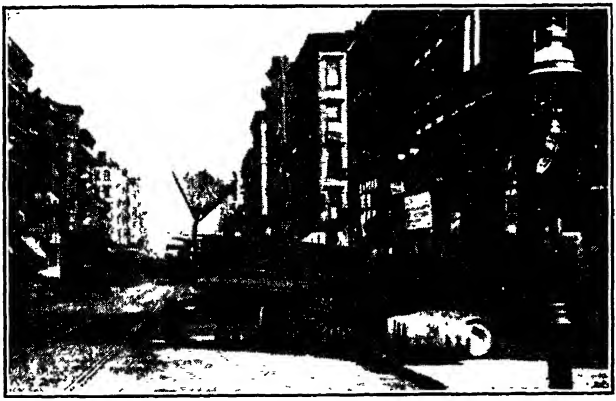
Position No. 4 is where the vehicle stands at right angles to the curb with the horse turned so as to take up a position about at an angle of 45 degrees from the curb. This position takes up less room than position No. 2, and allows vehicles to stand closer together than does position No. 3.

The actual space occupied by vehicles in this position varied from a minimum of 11 ft. 1 in. to a maximum of 19 ft. 2 in., with an average of 14 ft. 5 in.

The results obtained from the measurements were as follows:

No. of observations	Kind of vehicle	Average width of vehicle	Average extreme distance
25	1 horse truck	6′- 3⅝″	13′-2½″
29	2 horse truck	7′- 0¾″	15′-3¼″
4	3 horse truck	7′- 9½″	16′-2¼″
1	Auto truck	6′-10″	14′-2″

Positions No. 5 and No. 6 are where the vehicles stand at an angle with the curb line, and the space in the road-



Courtesy U. S. Wood Preserving Co

FIG 56—ONE SIDE OF ROADWAY BLOCKED BY TEAM BACKED AGAINST CURB, AVENUE C, NEW YORK

way taken up by the vehicle is dependent largely on the degree of angle. The results obtained were as follows:

No. of observations	Kind of vehicle	Pos. No.	Average width of vehicle	Average extreme distance
19	1 horse trucks	5	6′- 2½″	9′- 7″
26	2 horse trucks	5	6′- 7⅜″	12′- 2¾″
2	Auto trucks	5	7′- 3″	10′-11½″
1	Automobiles	5	6′- 2″	16′- 1″
30	1 horse trucks	6	6′- 2½″	7′-11¾″
25	2 horse trucks	6	6′-11½″	9′- 2¾″
2	3 horse trucks	6	8′- 3″	9′- 7½″
2	4 horse trucks	6	7′- 9½″	10′- 3½″
1	Auto trucks	6	6′- 8″	8′- 5″
1	Automobiles	6	7′- 0″	8′- 1″

The actual space occupied by vehicles in positions No. 5 and No. 6 varied from a minimum of 5 ft 7 in. to a maximum of 22 ft. 10 in., with an average of 9 ft. 9 in.

Further data were obtained as to the width of motor trucks and the space taken up by them in January, 1916. It was found, as the result of 29 observations, that the widths of motor trucks varied from a minimum of 5 ft.

FIG. 57.—ISLE OF SAFETY ON FIFTH AVENUE.

Courtesy U. S. Wood Preserving Co.

FIG. 58.—CHURCH ST., NEW YORK. TOO NARROW STREET, THOUGH ELEVATED ROAD DOES NOT INTERFERE.

6 in. to a maximum of 7 ft. 6 in., with an average of 6 ft. 6 in. In 16 cases they stood parallel with the curb in position No. 1,occupying an average distance of 6 ft. 2 in., with a minimum of 5 ft. 2¼ in., and a maximum of 7 ft. 7 in. In two cases they stood at right angles to the curb, occupying an average of 14 ft. 0 in., with a minimum of 11 ft. 10 in., and a maximum of 16 ft. 2 in. In eleven cases they stood at an angle to the curb in positions No. 5 and No. 6, occupying a minimum of 7 ft. 2½ in., a maximum of 16 ft. 8 in., with an average of 9 ft. 11 in.

From the data it can be seen that the space taken up by standing vehicles varies according to their position and that, unless the position they are allowed to occupy is regulated by ordinance and strictly enforced, they may occupy so great a space in a narrow street as to seriously hinder any moving traffic; especially when standing at right angles to the curb they may block up the entire width of the roadway.

An average of all the observations made in 1912 gives an average width, for all classes of vehicles measured, 6 ft. 9 5/8 in., with a maximum of 8 ft. 9 in. and a minimum of 5 ft. 4 in. The amount of space taken up by all classes of vehicles in all six positions gave an average of 12 ft. 6 13/16 in., with a maximum of 22 ft. 10 in., and a

Courtesy U. S. Wood Preserving Company.

FIG. 59.—ROADWAY CONTRACTION BY TEAMS STANDING IN DIFFERENT POSITIONS. Reade Street, New York, as it appears during almost any business day.

minimum of 5 ft. 4 in. It was observed that when vehicles stood parallel to the curb in position No. 1, they took up more room on the average than the total width of the vehicle, as the average width of the 41 vehicles measured in this position was 6 ft. 10 1/8 in., while the average street space occupied by them was 7 ft. 1 1/8 in.

CALCULATING ROADWAY WIDTHS.

In designing a street from a traffic standpoint, the widths taken by vehicles, both standing at the curb and moving, must be taken into account, so that the street space may be divided into multiples of street traffic. A certain amount of clearance must also be allowed between rows of moving vehicles, as they cannot operate unless such space is provided. If traffic widths of 8 ft. 0 in. are provided, there would be a clearance of approximately 16 in. between moving vehicles, and the maximum vehicle measured, having a width of 8 ft. 9 in. would not pass along the space at all, but would overlap it, causing all the other lines of vehicles to be crowded together. No room would be left for a pedestrian crossing the street who might get caught between two rows of vehicles and injured if only 8 in. clearance were allowed. In designing railroads, subways and street car lines, it is customary to allow at least 2 ft. 0 in. clearance, and preferably 3 ft. 0 in. between moving lines of cars, so that there will be a chance of life for any one caught between the cars. A better traffic clearance for designing street widths, therefore, would be to take at least 9 ft. as a minimum, thereby giving approximately 2 ft. 4 in. clearance for the average vehicle, and this would allow a vehicle of maximum size to pass.

Free wheel vehicles do not move in such exact paths as do railroad trains or street cars, as they are free to vary their path around obstructions and the drivers are not apt to follow fixed paths, but to seek the widest opening for their movement. The capacity of a street would, therefore, be somewhat greater than that estimated on this account.

If street car lines are placed in a street, it is customary in many cities to make the distance between track cen-

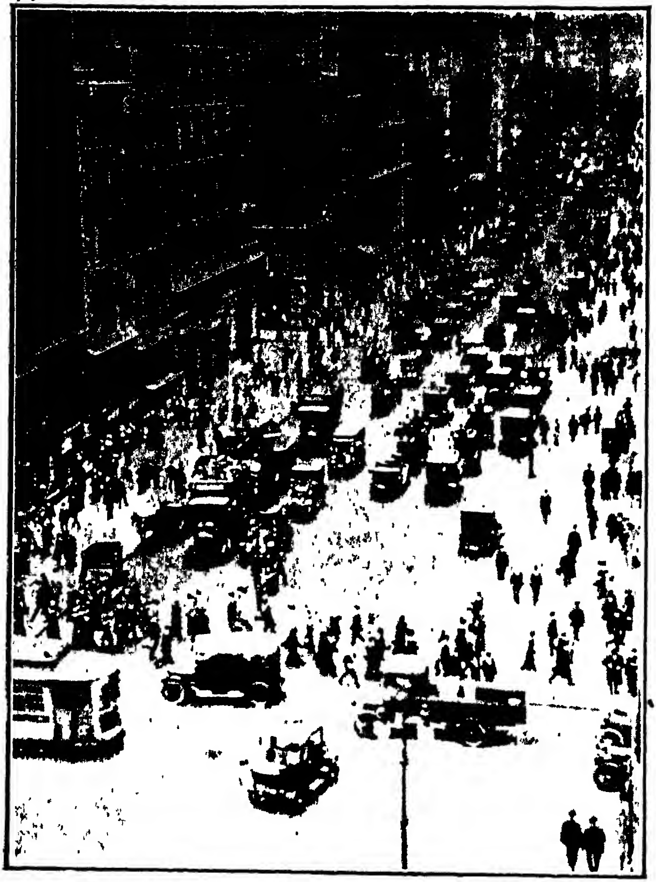
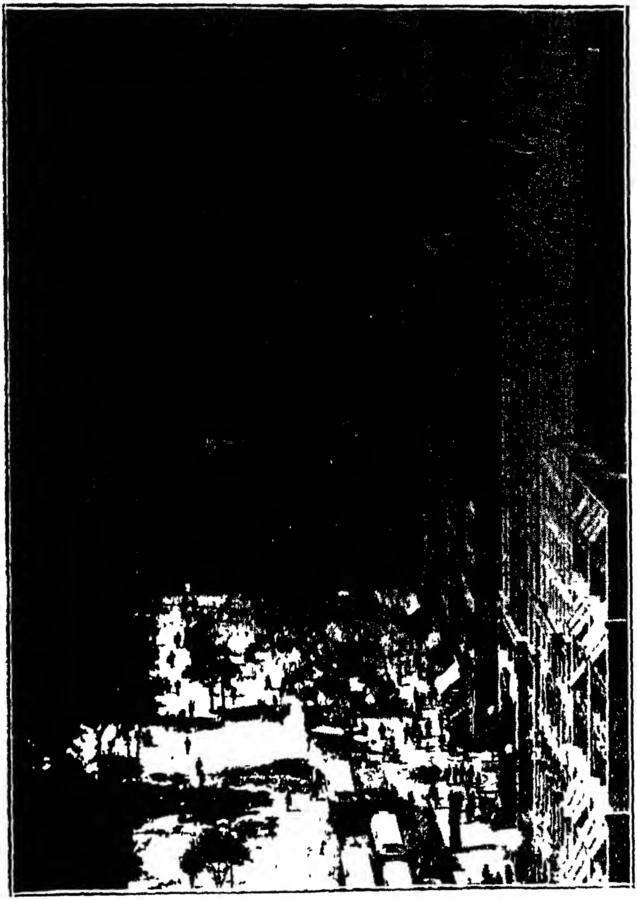


FIG 60—FIFTH AVENUE, NEW YORK, SHOWING SIX LINES OF VEHICLES



Courtesy U S Wood Preserving Co

FIG 61 BROADWAY, NEW YORK, OPPOSITE CITY HALL
Too narrow for two lines of traffic on either side of tracks, except at City Hall Park, at the left foreground

ters 9 ft. 0 in. This width, therefore, should be assumed for the space occupied by a single line of car tracks. Space for at least one line of moving vehicles should be provided and space for one line of standing vehicles, giving three lines of vehicles in each direction, or a total of six lines, if a two way street with a double track car line is to be placed there. This would give a roadway width of 54 ft. 0 in. between curbs. This would be the width if the standing vehicles were all made by ordinance to stand parallel to the curb. If they are to be allowed to stand in any position they choose, however, a greater width must be given the roadway, as it was found that the average width to be provided for was 12 ft. 6 13/16 in., which might be increased to 22 ft. 10 in., if no regulation at all were introduced.

On Fifth avenue between 32nd and 44th streets, which is its most congested section, traffic counts have been made showing as many as 510 vehicles passing a given 15 minutes, or one vehicle every one and three-seconds. They operate in a roadway 55 ft. wide, in which there are 6 lines of vehicles, 2 lines standing parallel with the curb and four lines moving, giving an average width of 9 ft. 2 in. for each line of vehicles to operate in. Measurements of the speed of traffic show that, owing to the congestion and also to the number of stops required at cross streets to permit crosstown traffic to operate, the average speed is slightly less than five miles per hour. Farther up the avenue, where the interruptions from crosstown traffic are not so great, the speed average rises to over eight miles per hour. The crossings at 42nd and 44th streets are further impeded by the presence of isles of safety which reduce the width of the available roadway about 4 ft., bringing the average width of space at this point for each line of vehicles down to 8 ft. 6 in., which causes congestion and impedes the speed with which traffic can move.

There are other factors entering into roadway operation which must be considered. For instance, if it is proposed to operate an elevated railroad in a street, the columns should be required to stand inside the curb, as the effect of the elevated railroad columns of the Second,

Third, Sixth and Ninth avenue lines is to render these streets less flexible for traffic. These columns stand far enough apart to allow a double track line to operate between them. They effectually block the operation of a line of vehicles outside of them in case a standing vehicle at the curb takes up a position at right angles to the curb. While the cost of construction of the railroad would be increased by using longer spans, still it is a question if the amount of space lost for traffic purposes, together with the loss of room for laying pipes, sewers, duct lines and other public utilities would not offset this.

CHAPTER X.

STREET WIDTHS

(Continued.)

SIDEWALK WIDTHS.

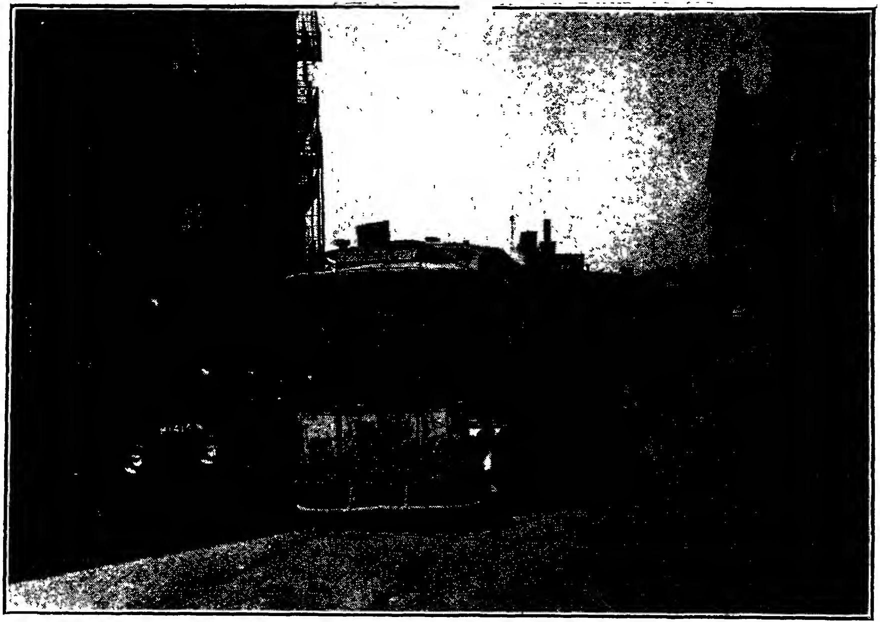
Pedestrian traffic on the sidewalks also must be considered in the design of streets. Our sidewalks are overcrowded in certain sections of the city, owing to conditions which could not be foreseen at the time they were designed. The maximum traffic recorded on New York sidewalks was 296,000 people in ten hours from 8.30 a. m. to 6.30 p. m. Along Park Row, just below the Brooklyn Bridge, there is an average of 29,600 per hour, or over 8 people per second. Counts for 15-minute intervals on this street have shown traffic to reach 4,288 people between 5.00 and 5.15 p. m., with 3,378 on one sidewalk, 3,000 of whom were bound in one direction. This would give a congestion figure of 14.3 people per foot of width per minute and represents a conditon of a tightly packed sidewalk with 89 per cent of the people moving in one direction to catch trains and trolleys at the Brooklyn Bridge terminals. At this time of day the pedestrian traffic on Park Row and Nassau street exceeds the capacity of the sidewalks and spills over into the roadway; Nassau street in particular is becoming a pedestrian street at these hours, with its sidewalks full and the roadway carrying nearly as many pedestrians in addition. The original settlers of Manhattan did not, of course, foresee these conditions and the only way to take care of such congested conditions is to turn these treets into pedestrian streets at certain hours, and to make one way streets of them for vehicle traffic. The width of sidewalk on Park Row between Ann and Beekman streets, where this traffic was taken, was 20 ft. 11 in., of which

5 ft. 8 in. at that time was taken up by encroachments along the building line, leaving only 15 ft. 3 in. of clear width of sidewalk for pedestrians. As a result of the traffic taken on this street, it was decided to remove the encroachments, so that now the full width of sidewalk is available.

It is difficult to estimate in advance the number of vehicles and pedestrians that will use a street. On Fifth avenue, traffic counts have given cases where there were between two and three times as many pedestrians as vehicles during the rush hours. The presence of some special objective point, such as a railroad terminal, would undoubtedly raise this average considerably and would present special problems. The pedestrian traffic should not exceed six persons per foot of width per minute for comfort to pedestrians passing in each direction, and it has been a rule in New York to take up the question of providing additional sidewalk space by such methods as removal of building encroachments when this limit was exceeded.

Courtesy, U. S. Wood Preserving Co.

FIG. 62—SIDEWALK OBSTRUCTED BY MERCHANT



Courtesy, U. S Wood Preserving Co.

FIG 63.—JUST ROOM FOR AUTO BETWEEN CURB AND CAR. HOUSTON STREET, NEW YORK.

STREET OBSTRUCTIONS.

The increase of traffic and the congestion caused by traffic on Fifth avenue, Broadway, Sixth avenue and many other streets in the business and financial districts of New York City has made it necessary in the past few years to provide some means of permitting an increase of both pedestrian and vehicular traffic. In order to do this, orders for the removal of all building encroachments projecting beyond the actual building line were issued and a readjustment of the sidewalk and roadway width was made, so as to produce a better proportion. For instance, Fifth avenue was originally laid out with a 40-ft. roadway and a 30-ft. sidewalk. On the sidewalk, however, 15 ft. of it had been allowed by ordinance for court yards, stoops, grass plots and other forms of sidewalk encroachments. With the increase of traffic, which came with the changing of Fifth avenue from a residence to a business street, the congestion on the roadway and sidewalk became so great that it caused a great deal

Courtesy, U S Wood Preserving Co

FIG 64—SIDEWALK CONTRACTED BY ENTRANCE ENCROACHMENTS.

of complaint and it was finally decided to order the removal of all of the encroachments, except certain forms of encroachments which formed integral parts of the building. These were permitted to extend 2½ ft. beyond the building line. This was done in order not to cause too great a hardship or expense to property owners. The roadway was then widened 7½ ft. on each side, giving 55 ft. for vehicles. The sidewalks also were widened to 22½ ft., or 20 ft. outside of the building encroachments. This gave 5 ft. more sidewalk space. Similarly on Broadway it was found that a readjustment of the sidewalk and roadway space could be made satisfactorily by moving the curb back 2 ft. on each side, giving room for a line of vehicles outside of the standing line next to the curb and increasing the available sidewalk width by removing all encroachments back to a line not exceeding 2 ft. from the building. Similar widening and removing of encroachments was undertaken on 14th, 23rd, 34th and 42nd streets, so as to furnish room for an additional line of vehicles on each side of the street, in order to relieve the congestion which had previously existed. It was also found that relief for congested sidewalks in the downtown financial district could be given by ordering the removal of encroachments on many of these streets. This work was done gradually and covered a period of several years, so as not to unduly embarrass property owners.

Safety islands have been proposed for a great many places in the city as a measure of safety for pedestrians crossing the street. Safety islands are very good things when properly used, particularly on very wide streets where the traffic is heavy. It is a question, however, whether safety islands are at all desirable or necessary on roadways which are less than 60 ft. wide, as a pedestrian obtains the safety he desires by waiting until traffic on the street which he wishes to cross is stopped by the traffic policeman on duty at that point. Safety islands were tried on Fifth avenue at 23rd street some years ago and are now being tried on 42nd and 44th streets. They do not, however, furnish the protection which their advocates claim for them and increase the difficulties under which traffic operates, as they take up

a certain amount of available space in the roadway, thereby crowding the vehicles closer together, and the presence of these islands in the middle of the street causes pedestrians to congregate on and around them, both above and below the actual safety island, so that there is considerable danger to pedestrians. The islands also impede the progress of fire engines and hospital ambulances, which customarily take the center of the roadway on a crowded street, the other vehicles crowding over to one side to make room for them. Several accidents to vehicles have been reported as a result of the safety islands. It has been suggested, however, that safety islands could be placed so as to be of great public benefit on West street, which has a very wide roadway with several lines of traffic moving on it, so as to form a protection for pedestrians having to cross the street in front of ferry houses and steamship piers. The presence of safety islands would also tend to prevent drivers

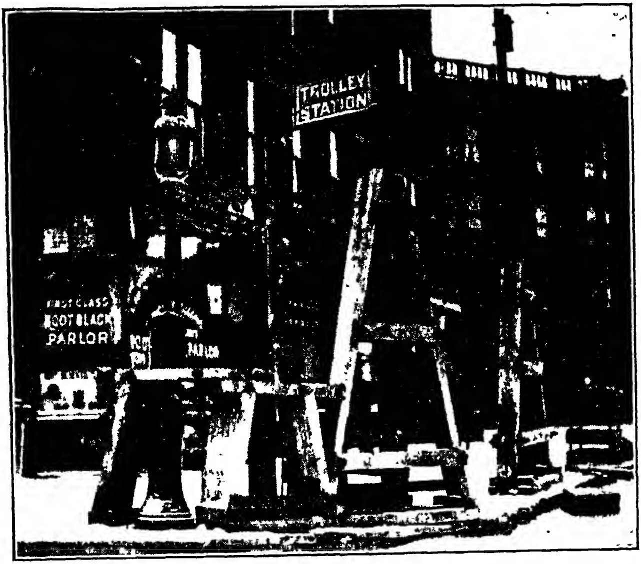


FIG. 65.—OBSTRUCTING STREET CORNER BY POSTS

of trucks driving at all sorts of angles across the street to reach their destination, as openings would be left at cross streets only and drivers would, therefore, be forced to pass through these openings in an orderly fashion.

There has been quite a little discussion recently of the question of properly ventilating subways and underground cellars by means of gratings on sidewalks. The writer has taken some statistics regarding the effect upon pedestrian traffic of the presence of subway gratings, from which there is an outrush of air every time a train passes. It has been found that a large percentage of the people walking on the sidewalk avoid the grating, owing to the unpleasant odors and difficulty of walking, and possibly the feeling of insecurity of walking over an open space. It has been urged upon the designers of subways to provide ventilation in some other manner than by using a certain area of sidewalk and thereby reduce the available width for the pedestrians. The same is true to a lesser extent regarding gratings over areas and ventilation provided in this manner for boiler rooms under the sidewalk.

The question of subway entrances and exits on the street has been quite a problem. The presence of a large subway stairway taking approximately half of the sidewalk has caused considerable congestion at these points, particularly because the entrances themselves increase the traffic due to the number of people going to and from the subways. There is also a desire on the part of the small vendors of newspapers, fruit, candy and shoe shining establishments to place their booths at these subway entrances, as, of course, the opportunities for their business are large at these places and the result has been that, in some cases, only one-third of the sidewalk would be left for pedestrians after the place had been preempted by the stairs and by the booths upon the sidewalk. A much better way would be to make some arrangement with the property owners to provide subway entrances through their basements. It has been found that such entrances and exits through buildings are of actual commercial value to the owners, who rent for business purposes the basement space which other-

wise would be useful only for storage purposes. In narrow streets in downtown districts, such as William street, where the roadway is approximately 20 ft. wide, with 10 ft. sidewalks, the presence of subway stairways on the sidewalk, taking up over one-half of the available sidewalk space, would be the means of causing great traffic congestion and should be avoided if possible.

The presence of loading platforms in front of warehouses and buildings of this type has been a serious problem to contend with. Where these old platforms exist, the trucks are backed directly up to them, thereby cutting off sidewalk space entirely from pedestrians, compelling them either to walk in the street or to climb up and down over a series of loading platforms which make a street of this character a series of hurdles. Of course, from the standpoint of the warehouse people the quickest means of loading and unloading their trucks is to back them across the sidewalk, but it would seem that this class of work could be done in a satisfactory manner by means of overhead beam trolleys extending out from the building, or by means of special freight elevators placed close to the curb line. This would leave at least two-thirds of the sidewalk available for pedestrians during the period of actual loading and unloading. Freight elevators were previously limited in New York

FIG. 66.—BLOCKING OF SIDEWALK BY OPEN ELEVATOR DOORS AND VEHICLE OVERHANG

FIG. 67.—SIDEWALK COMPLETELY BLOCKED BY VEHICLE AT LOADING PLATFORM

City to a space within 5 ft. of the building line, thereby causing the necessity of trucking the freight across the sidewalk to the inconvenience of pedestrians desiring to pass along the street. A much better method would be to place freight elevators at the curb line, so that the goods could be passed directly from the trucks to the freight elevators and taken down into the basement, leaving the inner portion of the sidewalk free for pedestrian traffic.

Formerly the radius of curb corners was fixed at 6 ft. in Manhattan Island. Since the advent of the automobile, however, it has been found that a larger radius is needed, in order to permit closer turning of corners, as the long wheel base in use for automobiles and auto trucks prevents them from turning close to a 6 ft. corner. After considerable study of the matter a new ordinance was passed increasing the radius for all new work to 12 ft., so as to adequately take care of this matter. If a larger curb radius was used there would be a tendency for drivers to operate around them at full causing danger of accidents, and it would a[illegible] considerable decrease in sidewalk area for pedestrians at this point.

The presence of numerous posts on the sidewalk, devoted to many different purposes, such as electric lights, fire alarm boxes, letter boxes, trolley posts, awning posts and fire hydrants, contribute to the disadvantage of the pedestrian in many cases. At least 2 ft. and in some cases nearly 3 ft. in sidewalk space is preempted by these posts and very often a greater number of them will occur on one corner which acts as a barrier to pedestrian traffic. The writer noted on one corner of Flatbush avenue, Brooklyn, seven different posts, so that less than 50 per cent of the width of the sidewalk was available for pedestrians.

Courtesy, U S. Wood Preserving Co.

FIG. 68—THE ROADWAY ABOVE, ADAMS STREET, CHICAGO, IS TOO NARROW FOR TWO VEHICLES TO PASS BETWEEN CURB AND DOUBLE TRACK, BUT WOULD BE WIDE ENOUGH FOR TWO ON ONE SIDE AND ONE ON THE OTHER IF THE TRACKS WERE MOVED OUT OF THE CENTER.

CHAPTER XI.

STREET WIDTHS

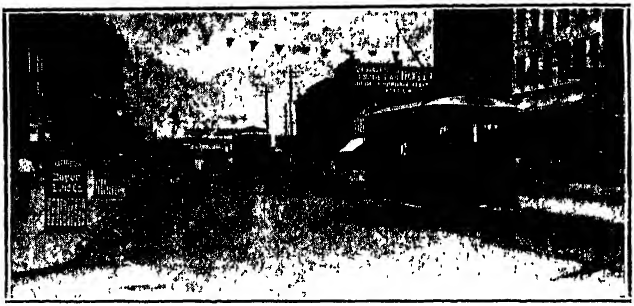
(Continued.)

So far as its use for carrying traffic is concerned, the proper width of a street is determined by the demands of the particular kind or kinds of traffic which it is designed to or may at any time be called upon to carry. In general the traffic may be divided into vehicular and pedestrian, while the former may be sub-divided into a number of classifications, prominent among which would be street railway cars; light, rapidly moving vehicles, and heavy, slowly moving vehicles. In the ancient cities the number of vehicles was so small relative to those which use the city streets of today that no special provision was made for them, but the entire roadway width was used in common by vehicles, beasts of burden and pedestrians. In country districts the same is still true. As we approach a village or other settled section, a foot path is usually found developed more or less continuously along the side of the road, and becoming more and more prominent and distinct from the roadway, until in the built-up and paved portion of the city we find the foot paths or sidewalks separated from the roadway by distinct lines and construction.

In some cases the division of roadway width is carried still further, and a separate strip is set apart for a street railway and used exclusively by it, although in the majority of cases the street railway strip is used more or less generally by the general vehicular traffic. In other instances we find special roadway strips set apart for fast and for slow moving vehicles, as bridle paths, bicycle paths and occasionally for other purposes.

Probably an ideal street so far as through traffic is

concerned would be one which has separate ways provided for each class of traffic, each separated from all the others in such a way that there will be no trespassing by any class of vehicle on the ways assigned to other classes. This, however, would add to the width demanded and would, in very few cases, be justified by advantages secured. For instance, in the city of small or medium size, it may usually be that a street railway track at any given point is passed over by a car only once in five to fifteen minutes, and during the intervals between such use there would seem to be no good reason why it could not be used by other vehicles. The chief objection to this would be the delay in speed of the surface car and danger to vehicles resulting from



Courtesy, Barber Asphalt Paving Co.
FIG. 69.—GENESEE STREET, SAGINAW, MICH.

the practice, and in a number of instances thorofares leading out from the city and carrying interurban lines have been constructed with a special strip for the street railway, separated from the remainder of the street by a curb or other obstruction.

As to the separation of vehicular and pedestrian traffic, where there is any considerable amount of both the interference of each with the other is so serious that there is universal agreement upon the desirability of such separation. There is a question, however, whether in the case of certain minor residence streets or others which are traversed by very few vehicles, the sidewalk

might not be omitted and the same pavement used for both vehicles and pedestrians. The principal objection to this is found at such times as the roadway is covered with snow or becomes muddy, since it is difficult to clean or to keep clean a strip for the pedestrians if it is being used several times a day by vehicles.

ROADWAY WIDTHS FOR MAIN THOROFARES.

Considering first the roadway of a main thorofare, we find the following elements of the problem: In the central part of the retail district there will be a great many vehicles standing still for several minutes at a time and some provision must be made for these. The most convenient point for them is close to the footway, since those riding in the vehicle ordinarily wish to alight from or enter the vehicle and to find ready access

Courtesy, U. S. Wood Preserving Co.
FIG. 70.—PARKING AUTOMOBILES ALONG CURB, GRISWOLD STREET, DETROIT.

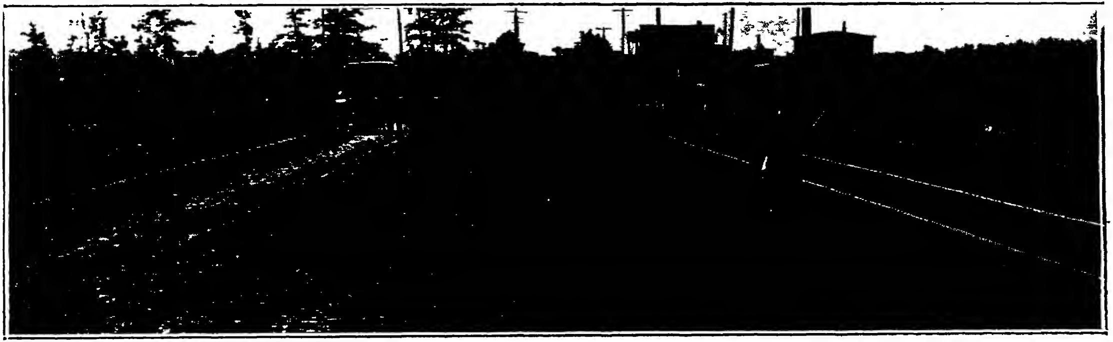
to the buildings facing the stopping point. In such section of the city it is therefore most important that we allow for a more or less continuous line of vehicles standing along the curb. Where sufficient space is not available along the curbs for all of the vehicles which wish to stand for a few minutes or hours in the business part of the city (and the number of such has been found to be increasing very rapidly with the advent of the automobile), it has been found necessary to provide what are known as parking places for leaving automo-

FIG. 71—A STREET IN POINTE CLAIRE, CANADA, CARRYING CONSIDERABLE TRAFFIC, 40 FEET BETWEEN CURBS (PROBABLY AMPLE), BUT WITH VERY NARROW AND OBSTRUCTED SIDEWALKS AND NO OPPORTUNITY FOR EXPANSION.

biles, these being located as near to the traffic center as possible. This matter will be considered later.

With a line of vehicles standing along each side of the roadway, we require, next, room for one line moving in each direction between these. (In the case of narrow streets where sufficient width for these two lines is not available, it is becoming common to establish these as "one way" streets, or those in which traffic is allowed to move in one direction only.) If the traffic moving through the street is such as to give an almost continuous line in each direction, then the entire line must move at the uniform rate of the slowest vehicle. Where, however, the vehicles in either line of motion are spaced at an average of more than, say, 150 to 200 feet apart, a vehicle desiring to pass another in the same line can do so when it comes opposite a break in the line moving in the opposite direction. There is, of course, danger that an attempt to do so will be made when the break

FIG 72.—WAGON STANDING PARTLY ON SIDEWALK BECAUSE OF NARROW ROADWAY AND PRESENCE OF STREET CAR TRACKS



Courtesy, Granite Paving Block Mfrs. Ass'n.

FIG 73.—STREET RAILWAY STRIP SEPARATED FROM ROADWAYS BY CURB, NEWARK TURNPIKE.

in the other line is too short to permit of it safely, and collision between vehicles moving in opposite directions may be more or less common. In a street of comparatively light traffic, however, where vehicles are seldom found less than a half block or a block apart, the slight inconvenience caused by such condition hardly warrants the expense of providing additional space for turning out. Turning out to pass will be considerably more convenient and safe, however, if a fifth strip be left in the middle of the roadway.

In a street with heavy traffic, it should be possible for the more rapidly moving vehicles to turn out of the line of the more slowly moving without danger of a collision, and in fact, provision should be made for two lines of vehicles, one traveling slowly and the other more rapidly, moving in each direction. This gives us six lines of vehicles, and it is seldom that more space is provided where only free moving vehicles (those not confined to street railway tracks) are concerned. Upon Fifth avenue, New York, one of the most heavily traveled streets in the country, there is room for six lines of vehicles and the drivers follow these lines quite closely.

Where there is a street railway in the street, separate provision should be made for this also if the cars pass at intervals of less than say two to four minutes. Where the passage of cars is infrequent, however, it is common for the rapidly moving free traffic in the center of the roadway to use the railway strip. This results in retarding the average speed of the street railway cars so long as they are in a main thorofare where the six lines of traffic are used to anything like their full capacity; since where this is the case the vehicles using the car tracks cannot leave them except by infringing upon the traffic strip allotted to the slowly moving vehicles or by turning into a cross street. It is, therefore, very desirable in a main thorofare which carries almost continuous traffic on each of the four lines described, and through which travel cars convening from several tributary lines of track into one trunk line near the center of the city, that a special strip be provided for the tracks.

considerations apply, except that the distinction between slowly and rapidly moving vehicles is ordinarily greater, and it is not so easy for the former to swing out from the general line of traffic to pass obstacles or to make way for other vehicles. Moreover, the trucks and other heavy vehicles using these thorofares will probably average wider than the miscellaneous vehicles using the general main thorofare. On the other hand, however, slowly moving vehicles do not need so wide a clearance between lines of traffic to prevent collisions, and occasional interferences of wheel hubs are not so serious, and the unit width employed for other traffic will probably be sufficient for this also.

In the above the average vehicle width is that considered rather than the maximum, but it should be remembered that the maximum will be infrequent and that the vehicles are free to move out of the straight line of travel and turn out a few inches now on one side and now on another and thus accommodate themselves to inequalities and exceptional extremes.

When we come to the minor thorofares, where it is seldom that more than one or two vehicles will be found moving at a given time in one direction within the limits of a given block, it might be considered unnecessary to provide more than one line of traffic in each direction; but in this case a somewhat more liberal allowance should be made to provide for extremely wide vehicles, for those which wish to turn around, or for an occasional vehicle standing parallel to or backed up against the curb. An average coal wagon backed up against a curb, but with the horse turned parallel therewith, will ordinarily extend for 11½ to 13 feet from the curb, measured over all. A moving van is frequently longer, but is generally set so as to overhang further beyond the rear wheels and 15 feet is ordinarily sufficient allowance to make for these. Owing to the infrequency of these in a thorofare such as we are now considering, it would seem to be sufficient to provide only for one line of vehicles to pass between such van and the opposite side of the roadway, this giving us a total width of

22 to 24 feet. As the width of 24 feet is also sufficient to permit two lines of vehicles to pass a third drawn up to the curb if we use the unit width of 8 feet which some advocate and which is probably ample if both use care in passing, this width would seem to be ample for a thorofare of this description. In many small cities the traffic even to the center of the city will be sufficiently accommodated by this width, although it is much better to provide for two lines of moving vehicles, or 36 feet, in the streets at the business center of even the smallest city.

This discussion refers to main and secondary thorofares only and not to minor residence streets. These last will be considered in a future chapter.

CHAPTER XII.

SIDEWALK WIDTHS

Concerning sidewalk widths there have apparently been even less definite ideas and arguments based upon actual observation than in the case of roadways. Mr. Hutchins, in Chapter X, spoke of a congested sidewalk in Park Row, New York, on which 3,000 people bound in one direction and 378 in the other passed along one sidewalk in fifteen minutes, giving 14.3 persons per foot of width per minute as representing a tightly packed sidewalk. He also states that New York officials consider that pedestrians should not exceed six persons per foot of width per minute for comfort, or about 40 per cent of the crowds which congested the sidewalk on Park Row.

If we consider the problem in detail, we find that, to move without crowding, there should be provided for each person an average width of 2½ feet. (We have seen 2 feet given as a unit, but this would be sufficient only for persons walking elbow to elbow, as in the case of soldiers marching.) Also, as no one pedestrian is probably keeping step with those in front and behind him, it is necessary that he be separated from each of these by the full length of step plus the length of his foot and plus a clearance of at least another foot to prevent stepping on the heels of the one in front, giving approximately 5 feet as the space longitudinally of the sidewalk required for each pedestrian. This gives 12½ square feet per person. Where the sidewalks are most crowded in the retail business district the rate of progress of the pedestrian probably does not exceed two miles per hour during the rush hours, since the crowding pre-

vents any from moving more rapidly than the few slowest, and delay caused at street crossings affects the entire moving column. When streets are less crowded, it is possible for those walking more rapidly to pass those walking slowly, but this requires an extra 2½ feet width for each person passed, and to permit perfect freedom of motion would seem to require an average width of 4 or 5 feet per person instead of 2½, giving 20 to 25 square feet per person. In addition, sidewalks in front of retail stores, where the most crowding is generally found during business hours, must generally be sufficiently wide to provide for persons standing in front of the show windows.

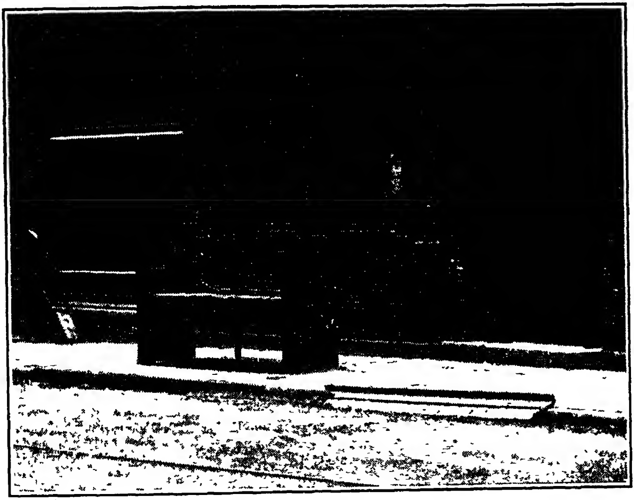
Using these figures, the velocity of two miles per hour is equivalent to 176 feet per minute; and taking 12½ square feet per person during rush hours, gives 14 persons per minute per foot width, or very nearly the figures of the actual count given above. Taking the second consideration, with 20 square feet per person and an average rate of 2½ miles per hour (equivalent to 220 feet per minute) the calculation gives 11 persons per minute without any allowance for those standing in front of windows, entering and emerging from doorways, etc., nor for any interference along the curb by fire hydrants, posts, and other obstructions. This is something less than twice the figures used by New York as securing comfort for pedestrians. It would appear, therefore, that their calculations or counts upon which this figure is based would allow for more freedom of movement than that just described; and there can be no question that this is desirable, especially in districts where a large percentage of the pedestrians are women shoppers whose speed of walking would probably average less than that given; and also in view of the fact that greater freedom of motion is desirable than that provided by affording only sufficient space for moving at a uniform rate or occasionally crowding past those in front. It would seem probable therefore that an allowance of six or eight persons per minute per foot of width would give a desirable width of sidewalk, there being added to this two or three feet additional to provide for those standing in front of windows and entering and leaving store doors.

Courtesy U S Wood Preserving Co.

FIG. 75—TYPICAL SIDEWALK CROWD IN PHILADELPHIA.

We still have left the difficult problem of estimating how many persons will wish to use the sidewalk during business hours generally, and how many of the employees or other occupants of the buildings facing thereon will use it in entering or leaving them within a very few minutes of the beginning and closing of business in said buildings. This number will depend to a large extent upon the nature of business carried on in the district, the average number of occupied floors in the buildings, the number of customers, employees or others which will probably visit such buildings for business purposes, and other considerations.

Probably the greatest congestion is that occasioned by factories, since all the operatives in these usually leave simultaneously at the stroke of the bell, while in office buildings there is a more gradual departure of clerks, business men and others. The number of operators permitted in a factory building is limited by law in many cities



Courtesy U. S. Wood Preserving Co.

FIG. 76.—SIDEWALK ON LARNED ST., DETROIT, SERIOUSLY OBSTRUCTED BY A FREIGHT ELEVATOR.

and states, this number being based upon square feet of floor area. The number of floors, however, is not often limited by law, but rather generally by economy in construction and operation. If we take a factory building 75 feet deep, 10 per cent occupied by walls, halls and other unused space and four stories high, and allow one operator to each 50 square feet of floor area, such a building would give 5.2 operators per lineal foot of street front. If we assume a block of such buildings 300 feet long and that all the operators in this block desire to travel in one direction, and that all will leave the several buildings within 10 minutes at quitting time, we would have the number arriving on the further corner of the block equal to 156 per minute. Allowing 8 per foot of sidewalk width per minute would give 20 feet as the width desirable.

In general, however, it is almost impossible to estimate what number of people a sidewalk will be called upon to accommodate. There may be some relation between the population of a city and the width of sidewalk desirable for the retail shopping district, but we know of no study which has been made along this line.

Aside from the question of *maximum* capacity of sidewalk, however, there is a minimum width desirable for numbers far less than such capacity. For instance, on

Courtesy Barber Asphalt Paving Co.

FIG. 77.—STREET IN CHICOUTIMI, QUEBEC SIDEWALKS TOO NARROW.

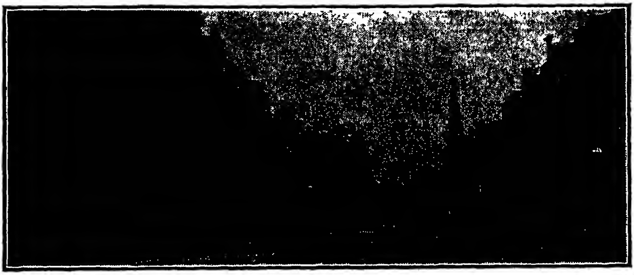
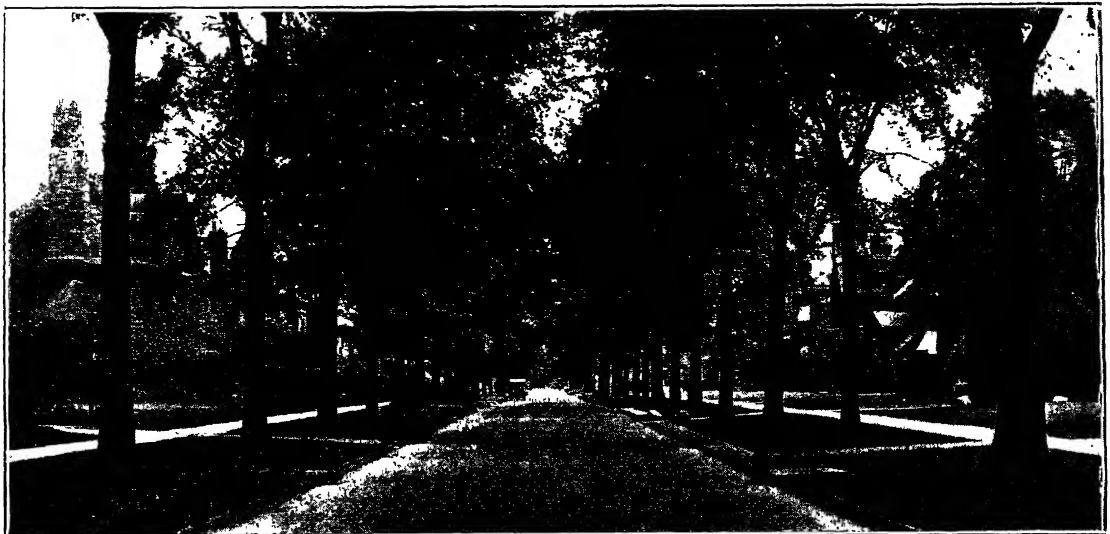


FIG. 78.—ENCROACHMENT OF RESIDENCE STEPS. BOSTON.

even a local residence street, or one where there is comparatively little use of sidewalk, it is desirable that two persons be able to walk abreast or pass each other in single file without interference. On streets used for general traffic it is desirable that two couples be able to pass each other, the four being abreast at the instant of passing. There may be residence streets or ways serving only a few houses where even the minimum referred to may be reduced to that necessary for one necessary for those moving in c each other being met by having one step onto the roadway or lawn; but this would probably occur only in the case of what are sometimes called "residence parks" or similar sections in which the rural effect predominates.

For two persons to walk abreast or to pass each other, we have seen that four feet is the minimum and that five feet is preferable. Several cities have made the paved portions of their sidewalks 4 feet wide, but this is generally believed to be inconveniently narrow, and either 4½ or 5 feet is much more common. To permit two couples to pass each other would require double this width, with a slight added allowance for clearance between the couples and for persons of unusual size. Ten feet would seem to be the minimum for such a sidewalk. A great many cities have set 12 feet as the width of sidewalk (fixing it as one-fifth of the total width of street, and 60 feet as the standard street width), but perhaps in the majority of cases this 12 feet width is more or less obstructed by encroaching door steps, trees, etc.



Courtesy Barber Asphalt Paving Co.

FIG. 79—EXCELLENT LOCAL RESIDENCE STREET—NARROW ROADWAY (ABOUT 25 FEET) AND WIDE PARKING (GIVING FLAT DRIVEWAYS). INSIDE PARKING COMBINED WITH LAWNS. FERRY AVENUE, DETROIT.

We may say, then, that for local residence streets a paved way of 4½ feet should be provided; while for all thorofares the minimum should be 10 to 12 feet, which should be increased to 15 or perhaps 20 feet in the main retail district. New York City, in reconstructing Fifth avenue and several of the streets in its retail business district, has made the sidewalk 25 feet where this can be obtained.

Most cities find it desirable for one or more reasons to plant shade trees along one or both sides of the sidewalk, and in the majority of residence streets to place these trees in a sodded strip following either between the curb and the paved portion of the sidewalk or between the latter and the building line, or both. Ordinarily the space allowed for the trees and also that for the sodded strip is narrower than it should be. Maples, elms and practically all shade trees, when they have attained approximately their full growth, have a trunk diameter of 15 to 20 inches, while at and immediately beneath the surface of the

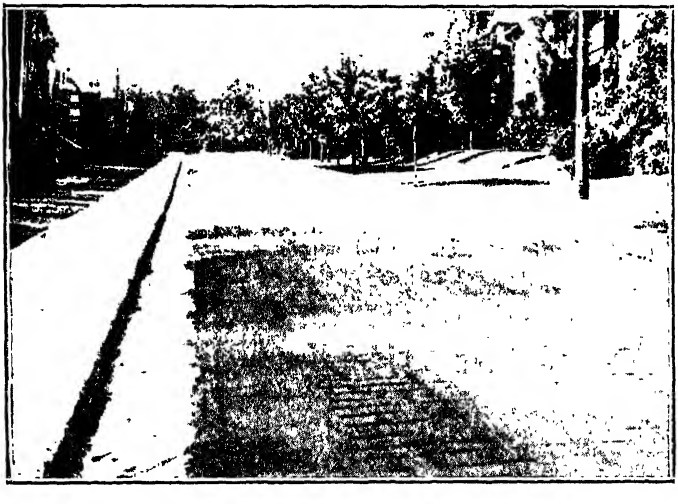


FIG. 80.—FORDEN AVE., WESTMOUNT, CANADA.
No planting strip between walk and gutter, but a wide one next to property line

ground the spreading of the roots occupy considerably greater area. If the sidewalk pavement is placed too close to the tree it will be lifted from grade or broken by the growing trunk and roots; if a curb is placed too near the tree it is apt to be thrown out of line; while if there is no curb, but a sodded or planting strip is sloped down to the gutter, and if the gutter is too near the tree, the roots of the latter are apt to be exposed, to the disfigurement of the sodded strip and the detriment of the tree. For these reasons, a tree should be placed with its center at least 2½ feet from either sidewalk pavement or gutter line, and 3½ feet would be better. This would give a width of at least 5 to 7 feet between curb line and sidewalk pavement. This distance is frequently found reduced to three or four feet, but almost invariably with the results noted above if the tree has attained anything like full size.

Aside from the question of trees, there is objection to having a sodded strip too narrow and 6 or 7 feet is much preferable to the 3 or 4 feet so often seen. One reason for this is that, either because it is difficult to mow (especially where there is no curb) or because it seems almost too trifling in size to pay attention to, it seems to be the general experience that narrow sodded strips are frequently neglected and allowed to grow untrimmed, while

FIG. 81.—STREET IN BEN AVON, PA. PARKING TOO NARROW FOR PLANTING TREES OR FOR APPEARANCE.

FIG. 82.—SHRUBBERY PLANTED IN PARKWAY OF STREET IN COLUMBIA, S. C.

this is much less likely to be the case with the wider strips. Aside from this, however, in the opinion of most who have given thought to city planning, the appearance of a street is much more pleasing where wide sodded strips are used than where these are made narrow. Where the sodded strip is between the pavement and the property line and is joined on the other side of the property line by a lawn, and especially where there is no fence or hedge between the two, the above of course, does not apply to such strip, which is in fact merely a slight extension of the lawn and is trimmed and otherwise treated in connection therewith.

If we consider a residence street with shade trees and sodded strip, using the above suggested dimensions, we may have a minimum of 5 foot sodded strip and 4½ foot pavement, or preferably a 7-foot strip and 5-foot pavement. In either case, but most certainly in the former, it is desirable that an additional space of a foot or two be left between the pavement and the property line to prevent the necessity of pedestrians crowding against buildings which have been placed on the property line. For this reason from 1½ to 3 feet should be added on the inside of the pavement, giving a total width of 11 to 14 feet.

Where the sidewalk pavement is placed immediately adjacent to the gutter and the planting strip, if any, be placed between that and the property line, this sidewalk width may be considerably reduced, allowing, say 5 feet for pavement and 2 feet for strip between this and the

property line, or 7 feet altogether. This, of course, would provide for no shade trees unless these be placed on private property.

In planning the sidewalk width, as in the roadway planning, provision should be made for the possibility of a change in character of the street which would bring to it more extensive traffic than was anticipated, and a 10 foot pavement with 2 feet clearance next to the building lines should ordinarily be the minimum allowed for in fixing the total width between building lines. This matter of providing for possible future changes in width of sidewalk, as well as roadway, will be discussed in a future chapter.

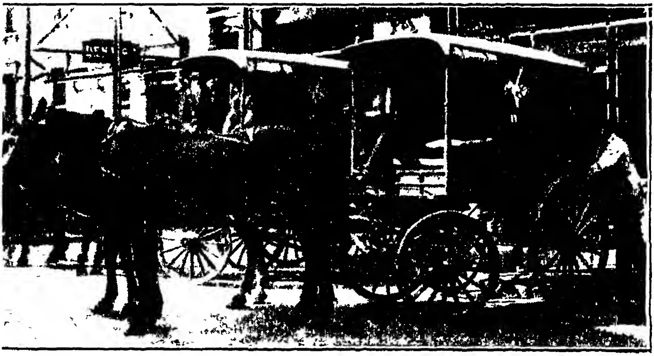
CHAPTER XIII.

MINOR RESIDENCE STREETS

We have already referred to the width of sidewalk for minor residence streets, but in the matter of roadways have considered only those for thorofares. In a thorofare the chief consideration is convenience of the traffic which passes through; it being generally the case that if this is amply provided for, so far as width is concerned the requirements of the residents thereon will be fully met. In the case of minor residence streets, however, the consideration is chiefly that concerning the residents and only incidentally concerning the traffic. In fact, it might be argued with considerable reason that any residence section should be laid out, not by designing the streets and locating residences upon them, but by locating residences in such a way as to secure for their occupants the greatest comfort, convenience, health and pleasure, and then adapt the streets so as to give the necessary access to the houses so located. For instance, instead of a city's fixing by ordinance that no street should be less than 60 feet wide, it might state that no house should be placed with less than 60 feet between its front and any portion of a house opposite, and that no one acre of land should contain more than a certain number of residences or be covered to more than a certain percentage of its area by buildings; leaving to be decided individually for each case, either by the owner or by a city official, what width of roadway and sidewalk was best suited to serve houses so placed. This phase of the subject, however, will be considered at somewhat greater length later on. In discussing the width of roadway and sidewalk, however, it should be understood that the actual open space between houses is in no way considered.

In a local residence street practically the only vehicles ʳhich use the roadway are the various delivery wagons ʳhich visit the houses on the street in question each day nd the carriages, automobiles or other vehicles which ıay be used by or bring their owners to call upon the esidents on this particular street. Where the residents wn or are visited by pleasure vehicles they are generlly well-to-do, the houses will ordinarily be placed some istance apart, so that the number in any one block will e few; while on the other hand, where the population er acre approaches the maximum, the residents are probbly of the poorer class and provision need be made for elivery wagons only.

Under such conditions it is apparent that provision need e made for only two vehicles to pass each other, or one ɔ pass another standing at the curb. The occasion when wo moving vehicles would wish to pass while opposite a ıird vehicle would be so infrequent as not to call for any onsideration, since this involves only a moment's delay n the part of one vehicle or the other to effect the passıg. If we allow 9 feet per vehicle, this would indicate ıat an 18-foot roadway would be ample, and under many onditions, especially where the street in question extends ɔr only one block from a thorofare, the roadway might

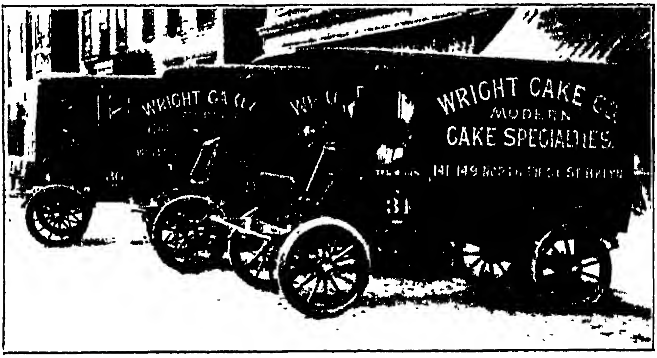


ourtesy, Commercial Vehicle

IG 83.—HORSE DRAWN VEHICLE OCCUPIES 17 FEET OF ROADWAY WIDTH

be confined to this width. A coal wagon backed against the curb would occupy about 13 or 14 feet and thus would practically block such a roadway, but in a street occupied by houses with fairly large grounds and setting well back from the roadway, the number of hours per year during which coal wagons would be standing in the roadway would be comparatively few; moreover it would not be at all necessary for the wagon to stand in this position, since the house would be so far from the road it would be impracticable to chute the coal from wagon to cellar, but it would need to be carried in baskets or bags, and for this purpose the wagon could be drawn up along the gutter rather than backed up to it, thus leaving the roadway open. The same would be true of the occasional moving van whose visit would be infrequent and which could, if desired, be loaded side-to rather than backed to the sidewalk. If, however, provision is desirable for vehicles standing in this position, the width of 14 plus 8, or 22 feet should be ample for almost any purpose.

The difference between the 18 and 22 feet represents 4 square feet for each running foot of street, or 4/9 of a yard. Estimating that paving the roadway costs $1.50 a square foot, this means a saving of $0.67 per running foot, or $33.33 for each 100 feet laid on each side of the street. If



Courtesy, Commercial Vehicle.

FIG. 81- MOTOR VEHICLE OCCUPIES 11 FEET OF ROAD-WAY WIDTH.

the property owners are assessed for the cost of paving, it might be interesting to place the proposition before them in these terms of dollars and cents and ask if they consider the additional 4-foot width worth to them this cost of $33.33 for construction together with future costs for repairing and reconstruction. From the city's point of view, it may be considered whether it is desirable to incur, for this additional width, the added cost of cleaning, sprinkling, oiling and otherwise maintaining this additional width.

There are other considerations less apparently bearing

FIG. 85.—RURAL TREATMENT OF RESIDENCE STREET.
Park Avenue, Glencoe, Ill.

on the subject; for instance, since a street pavement is much less impervious to rain water than lawns and yards, the wider the roadway the greater the amount of run-off to the sewer, and consequently the larger the sewers required to remove the surface water. If, as would probably be the case in an ordinary street of this kind, the roadway be made of macadam, gravel or other of the more easily abraded pavements, practically all of the dust reaching the houses, lawns and those using the sidewalks originates on the roadway, and the wider this is the greater the amount of dust raised. (The increase would not be

FIG. 86.—FOREST PARK BOULEVARD, FT. WAYNE, IND.
Note hydrant in Parkway and absence of shade trees.

in a constant ratio, however, since the amount of dust would depend to a considerable extent upon the number of vehicles using the street.)

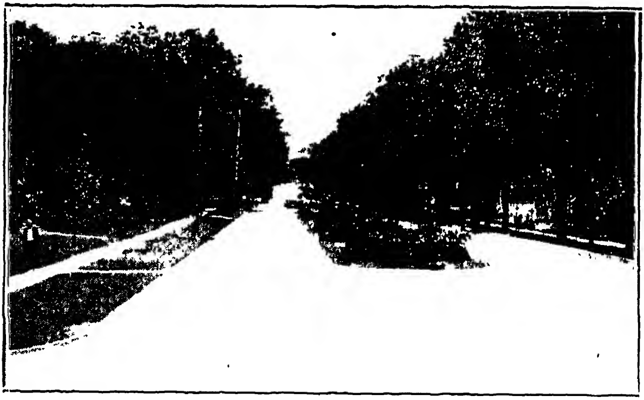
When the street under consideration is what is known as a "blind" street (is connected at only one end with a thorofare or other street) it is necessary to provide that any vehicle which may use the street can turn around, and some have argued for this reason that the entire roadway should be made of sufficient width to allow a coal truck or moving van to turn at any point. This seems unnecessary, but a sufficient plan is to make a loop at the end of the roadway of sufficient radius to permit any vehicle to pass around it; the space enclosed by the loop being sodded, planted to flower garden or shrubbery or otherwise made an ornamental feature. Where the street is not a "blind" street, any vehicle unable to turn

FIG. 87 - ROADWAY UNNECESSARILY WIDE FOR LOCAL STREET AND SIDEWALK SPACE TOO NARROW NO PLANTING STRIP.

in an 18 or 22-foot roadway can, with little or no inconvenience, continue through the street, in the same direction as it entered it, to the next cross street or thorofare, instead of turning and retracing its route.

It is not our purpose here to cite in defence of a narrow roadway the many arguments based upon attractive appearance. These can be found in many works on city planning, the authors of which are practically unanimous in favoring narrow roadways for minor residence streets. Nor will we discuss at length the financial advantages, since these must be evident on the slightest consideration. There are scores of cities which have mile after mile of minor residence streets, built to a standard of 60 feet total width with 36-foot roadway, where an 18, or at most a 22-foot roadway would be ample. The difference between the 22 feet and the 36 feet is something over a yard and a half of roadway per running foot of street, or more than 8,000 yards per mile. Any superintendent of street construction, street maintenance or street cleaning can readily figure that this would mean a saving each year in his department.

This is not, it is true, a total saving. The width thus saved it is not proposed to eliminate from the street al-



Courtesy, Barber Asphalt Paving Co

Courtesy, Barber Asphalt Paving Co.
FIG. 89.—NORTH WALDRON BOULEVARD, MEMPHIS, TENN.
A well-designed street of pleasing appearance.

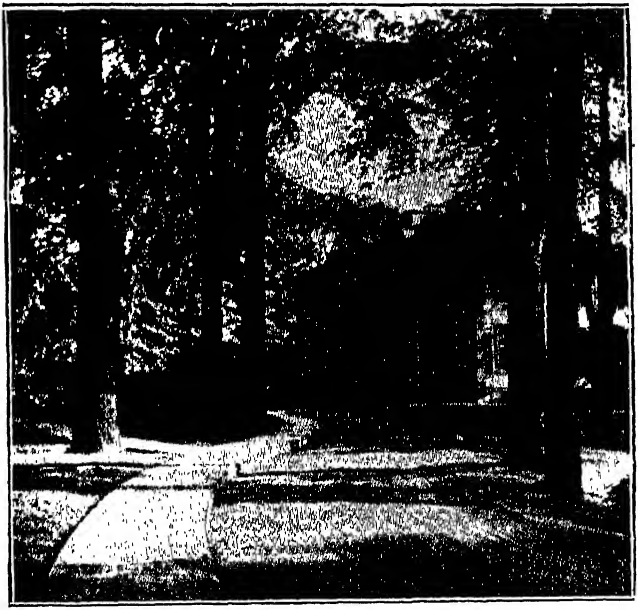


FIG. 90.—LOCAL RESIDENCE STREET, OR BY-STREET

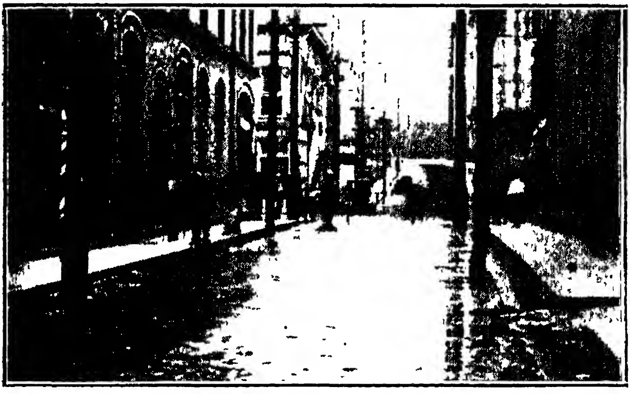
together, but rather to convert it to other use; and it is, in a great majority of cases, planted to lawn or occasionally to shrubbery or flowers. (The treatment of this extra width will be discussed at length further on). Planting and care of these involve some expense and trouble to either the city or the abutting property owner or both. If they are not carefully attended to, if the grass is allowed to grow untrimmed, flowers and shrubbery to be broken down, die or otherwise become eyesores rather than adding to the attractiveness of the street, it might be that this additional width would better have been left in the roadway, even though no expense be placed upon it for paving, but only for the ordinary grading and an annual scraping of the dirt-shoulders of the roadway. This matter of treatment of narrow parkways, planting strips and other portions of streets devoted to vegetation is one which needs more serious consideration by citizens generally, especially in those streets and sections where the residents take little pride in the appearance of their surroundings. Much can be done, it is believed, towards [illegible] pride in almost any of our citizens; the first move towards it should be an effort on the part of the city to set an example in the case of such small parks, parkways and other areas as it itself may own or control.

CHAPTER XIV.

LOCAL AND ELASTIC STREETS.

WIDTHS BETWEEN BUILDING LINES.

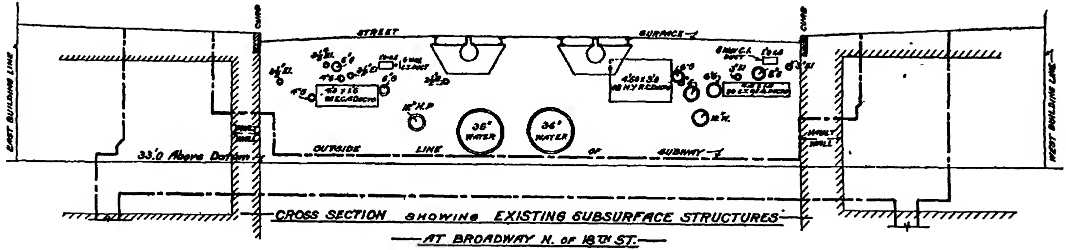
In the case of local residence streets, in addition to width demanded by traffic, the matter of open spaces around the houses as it affects the health and pleasure is important. It is customary for cities to limit the area of building to some percentage (65 to 90 per cent in different cities), of the lot; but if the streets are to be designed by the private owners of the property being sub-divided, a better plan is to fix a percentage of the



Courtesy, U. S. Wood Preserving Co.

FIG. 91. LEE STREET, BRISTOL, VA.

Roadway has been widened by narrowing the sidewalks. In moving back the curbs, the poles have been left standing in the roadway, which reduces the width of this available for any but standing vehicles, and introduces an element of danger to moving vehicles.



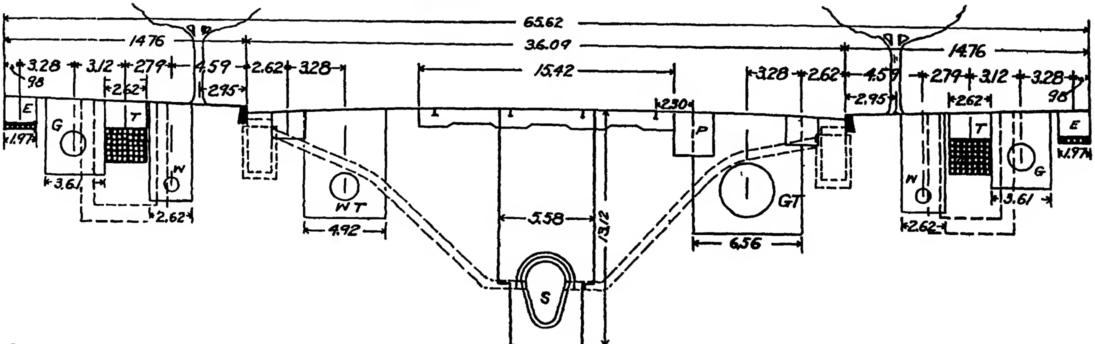


FIG 92.—LOCATIONS ALLOTTED TO VARIOUS SUBSTRUCTURES IN HAMBURG STREET, 20 METERS WIDE.

The arrangement varies somewhat with the width of street. E—Electric light. G—Gas. G T—Trunk gas main P—Street railway cable. S—Sewer. T—Telephone cable conduit. W—Water main. WT—Trunk water main. The dotted lines under the curbs show the catchbasins, and those around the telegraph conduits indicate the manholes for these.

FIG. 93.—FAIRFIELD STREET, SALEM, MASS.

Roadway has been narrowed to present requirements by moving out both curbs, thus providing a planting strip along the outside of each sidewalk.

total area, from street center to street center, which can be built upon. It would be well also to limit the height of building, or its cubic contents relative to the total area.

The streets of most cities occupy 25 per cent to 40 per cent of the entire area of the city, and if 65 per cent of the remaining space be built upon, we have the built-over area amounting to 39 per cent to 49 per cent of the total area. Considering a block 150 by 500 feet bounded by 50-foot streets and containing houses averaging 25x40 feet in plan, 39 per cent would permit 42 houses on the block, or one for each 24 feet front. In other words, building solid rows of houses 40 feet deep on a lot 75 feet deep and occupying 39 per cent of the total area would give 50 foot streets. This should be a maximum density for residence areas; and occupying 25 per cent of the total area by building would be desirable as a limit set by ordinance on the sub-division of private property for residences in outlying districts.

In laying out such a district on this principle, therefore, we may decide the average size of house which will be built upon the property and the widths of lots, and

FIG 94.—MAIN ROADWAY IN CENTER; SERVICE ROADWAYS AT SIDES; PARKWAYS BETWEEN.

Main roadway about 35 ft.; parking strips, 8 ft.; service roadways. 10 ft.; sidewalks, 16 ft.

from this calculate the average depth of lot measuring from center of street to rear line of lot. Double this will give an average distance apart of street center lines. The whole layout of street center lines can thus be designed, and then the width of sidewalk and of roadway be determined according to personal ideas of the designer or property owner, limited by ordinance requirements. Among the latter it is very desirable to specify the minimum distance each building must be placed from the center line; which may be given as the height of the building eaves above the roadway level, with a minimum of 30 feet; or different standard distance for different kinds of buildings, etc. Exceptional cases would be made of one-sided streets on hillsides, opposite parks and other open spaces, etc.

It is most desirable, especially for residence streets and streets on hilly or uneven ground, that the street be laid out approximately on the ground before the plan is finally adopted and that the layout be studied, with a consideration of the propositions already stated and also of the design of details, grade as it affects traffic, economy of construction, etc. Of course, a contour map of the property will have been prepared before any planning is begun, unless the land is all practically level.

ELASTIC STREETS.

A street which may some day be used as a main thoroughfare, but is now a minor thoroughfare or a residence street only, should have the width between buildings requisite for a main thoroughfare.

Preferably the city should own this entire width from the outset. Some state laws and city charters provide, however, that the city may prescribe a building line for any given street, beyond which it is illegal for any building to be constructed, although the city may not immediately possess as public property the entire width to this line. This permits the acquiring by the city at any time of the increased width necessary for increased traffic demands, without the necessity for purchasing or moving buildings.

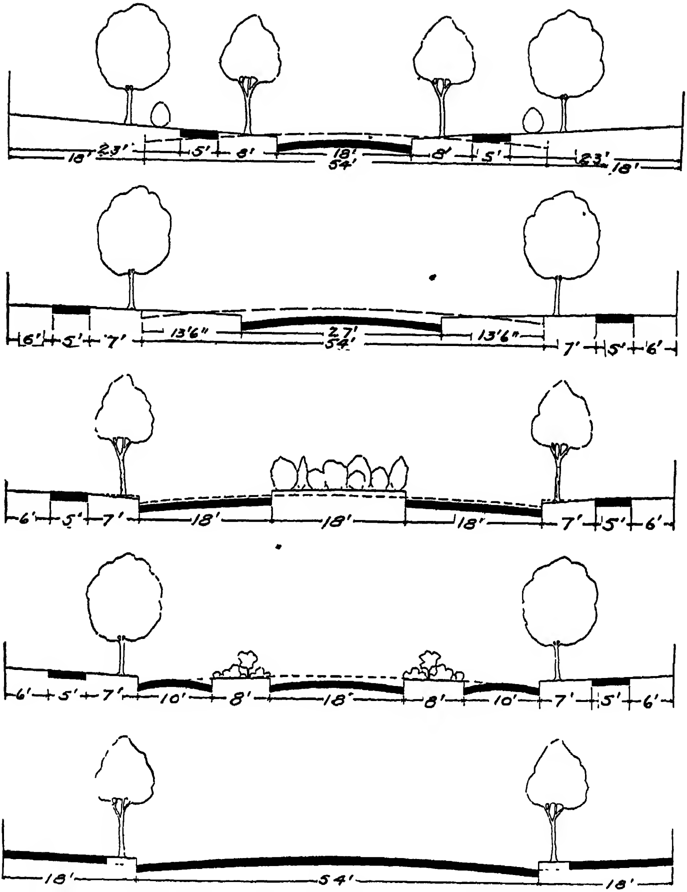


FIG. 95—VARIOUS STAGES OF AN "ELASTIC" STREET NINETY FEET WIDE.

In the lowest section is shown the street in its final condition, as a thorofare providing for six lines of vehicles and two 18-foot sidewalks The other four sections show different ways of treating the street temporarily during years of light traffic. In all of them the shade trees remain in the same position; but in the first one two additional rows of trees are provided. The dotted lines represent the final construction

In the immediate laying out of such a street, roadway and sidewalk widths are adapted to the present conditions on the principles already discussed. What is done with the remainder of the width must be determined by individual judgment and local conditions, topographical and otherwise. The superflous widths may be concentrated on one or both sides of the strips paved for immediate use, thus becoming in effect extensions of the private property; or they may be distributed across the roadway section as planting strips or narrow parkways, located either in the middle of the street or on one or both sides of the two sidewalks. Streets so designed for future widening are termed "elastic" streets. Where it is practicable (as it very frequently is), it is desirable to so plant shade trees that they can be useful in not only the present but also in the ultimate street plan, to establish grades of roadway or sidewalk or both so that little alteration will be necessary, and to locate catch-basins and other structures, both surface and underground, so that they will not need to be changed with the

Courtesy, U S Wood Preserving Co

FIG 96—PROVISION FOR WIDENING ROADWAY WITHOUT DESTROYING TREES SEMINOLE AVE, DETROIT

widening; all of which makes for economy. This is especially desirable in the case of trees, which it is impracticable to replace full-grown in new positions when the street is widened.

Anticipating future conditions in this way necessitates planning the future as well as the immediate construction of the roadway, and at least planting trees so that they will be retained and occupy a desirable position in the final plan. Other trees may be planted also, to be removed when the street is widened; generally only when the temporary plan will continue for a number of years. The grades of the temporary plan should be so designed that at the location of the trees there will be no change in elevation of surface in changing to final plan. This is also desirable in the roadway, as far as possible. There is an advantage, however, in raising the crown of the new roadway three or four inches above the surface of the old; for in case the old was a macadam road, it will probably have worn down two or three inches, and a brick or other block pavement can be placed upon it as a base without disturbing it; or whatever the pavement, a new surface can be placed upon the old base, either directly or after increasing the thickness of said base.

The adapting of elastic streets to present requirements by building narrow pavements may save very considerably in the cost of paving and cleaning and otherwise maintaining the pavement, together with the other arguments against wide roadways already referred to. Much more important is the providing of sufficient width for future requirements. Many of our older cities have spent millions of dollars in condemning or otherwise purchasing private property, destroying buildings etc. in order to secure width absolutely demanded by present traffic requirements.

CHAPTER XV.

PHILADELPHIA ELASTIC STREETS

While a great many cities of the country have been discussing town planning and several have secured, either by municipal expenditure or through local organizations, reports of experts upon the application of town planning to their particular community, Philadelphia is one of the few cities where town planning has been developed as a system and carried on as part of the routine work of a regularly organized branch of the public service. For this reason this city probably has available more ideas concerning town planning which have been actually tested in practice than almost any other city in the country. This gives special importance to a matter which was recommended to council by the Board of Surveyors (equivalent to a department of public works) and later adopted by council and made a city ordinance, and which by action of the board was made a part of the regular department work a few weeks ago.

The board of surveyors appointed a committee to formulate a plan for the uniform and systematic regulation of street development, and this committee reported last year, advocating the so-called elastic principle in street planning. The arguments and recommendations (omitting references to local matters only) were as follows:

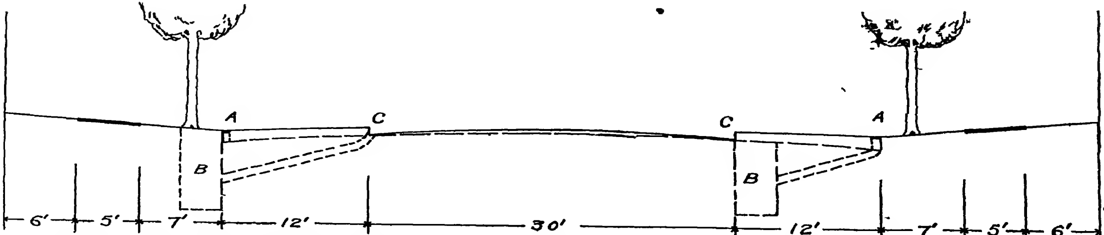
The modern tendency in street planning is toward a marked differentiation between streets intended for traffic uses and those for residential purposes, and a primary system of wide streets for the former has become necessary to meet the constantly increasing demands for urban circulation. But few such streets are needed in their maximum width until long after their opening and during the period while they are growing in importance as traffic carriers, full width paving is not necessary and the cost of construction and maintenance can be greatly reduced by paving road-

ways and sidewalks for only such portions of their width as may be needed for traffic uses in the near future, leaving the unpaved spaces for grass plots and trees. The inflexibility of the widths as established under our present laws prevents this being done except under what is known as the "Ayres" Ordinance, passed in 1891, to provide for grass plots and rows of trees. This ordinance appears to have been passed primarily for the purpose of increasing the attractiveness of the streets, but considerable economy could have been obtained by a more general carrying into effect of the authority conferred by it. The roadway widths provided by it, however, do not seem to be properly apportioned for traffic purposes if the best theories of economic street planning are considered.

Many city planners advocate the establishment of widths of street sub-divisions in accordance with a system of units for the various kinds of traffic, the widths being based upon a unit of 8 or 9 feet for each line of vehicles, 2 feet for each line of pedestrians, and multiples of the pedestrian width for grass plots, the latter to contain rows of trees wherever desirable.

The custom that has prevailed heretofore in the improvement of sidewalk spaces has been productive of much irregularity of construction and shabbiness of appearance of these spaces upon main streets; and even in the same block are found footwalks paved of varying widths, grass plots of varying widths and tree lines located at varying distances from the curbs. In improving the sidewalk spaces there should be greater uniformity and there should be standard widths established upon each street for paved spaces and for grass plots where such are laid out; also standard locations for rows of trees.

The theory of economic widths of roadway may be well illustrated in our streets 80 feet wide upon which the roadways are usually confirmed of the width of 44 feet, which roadways, under the Ayres Ordinance, would be narrowed 5 feet upon each side to the width of 34 feet. Neither of these widths corresponds with the unit of either 8 or 9 feet for a line of vehicles, but they are not seriously out of proportion unless they should be occupied by either a double or single track street railway; in case of the single track railway the width of 34 feet leaves a space on either side much greater than is necessary for the safe passage of a vehicle, while the width of 44 feet leaves just sufficient space for the passage of two vehicles upon either side. In the case of a double track street railway, usually placed in streets of this width when occupied at all by tracks, the width of 34 feet does not leave sufficient space for the safe passage of a vehicle, while the width of 44 feet leaves much more space than is necessary for one vehicle upon either side and not nearly enough for two It therefore seems



Elastic street with sidewalk strip draining to sod gutter and park inlet A. Catch basin B can be placed under inlet A in permanent position, or in temporary position under temporary gutter inlet C.

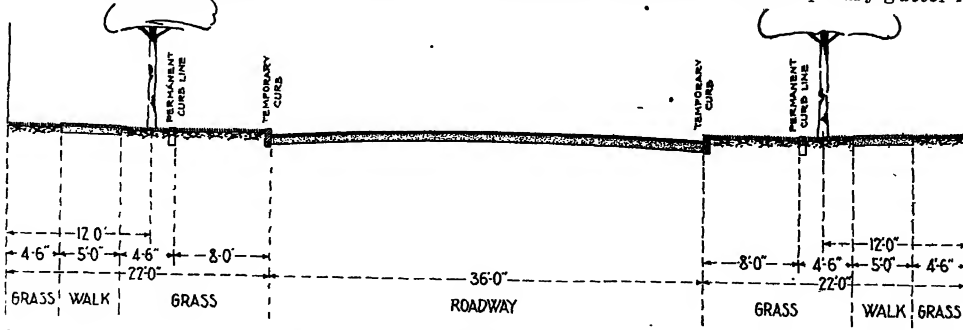


FIG. 98.—PHILADELPHIA'S STANDARD ELASTIC STREET. TEMPORARY SECTION FOR 80-FT. STREET.

Adopted in January, 1916. This provides for a 52-ft. roadway in its final form. All posts and poles other than those used only for the support of lights are to be located in the line fixed for trees. All water and gas stops and sewer vents are to be located at the owner's option either on the footway 1 foot inside of the permanent curb line, or within the outermost 1 foot width of the temporarily paved portion of the footway.

economical in establishing the widths of roadways upon streets which may be required to carry heavy traffic, with double tracks, to plan them for a certain number of lines of vehicles of the unit widths between tracks and curbs, allowing at least 18 feet for a double line of street cars; this in the street 80 feet wide with a vehicle unit of 8 feet would make the roadway width 50 feet. The unit standard should not be applied too arbitrarily, however, and 52 feet is suggested as the proper width for a roadway for six lines of travel, including two street car tracks.

A roadway 52 feet wide is rarely needed in a street at the time of its original paving, as it is usually many years before such width is necessary for traffic purposes, and it is in the original paving of wide streets that the theory and economy of the elastic principle is best illustrated. A width of 36 feet would, in a great majority of streets, be ample to carry all traffic, including double track street railway, for a long period of time, and, except for some special reason, the roadway should be improved of this width with provisions for future widening. In the case of an ultimate roadway width of 52 feet, this would temporarily increase the planting width 8 feet on either side, and trees should be set back far enough to avoid disturbing them by future widening; the economy would consist in the difference in the cost of constructing and maintaining 16 feet of grass plot for an indefinite period as against the construction and maintenance of 16 feet of unnecessary and unattractive pavement. Estimates of the cost of various forms of cross-sections for streets varying from 50 to 150 feet in width, based upon 25 year periods, show a saving of from 30 to 50 per cent in favor of the elastic street.

Standard locations for underground structures have been in use to some extent heretofore and we believe these standards should be fixed and uniform wherever possible. We have endeavored to interest the various bureaus in the importance of this subject, but find a lack of interest and co-operation in it. We therefore have confined the ordinance to the surface structures.

In connection with this report, the committee submitted about 25 standard cross-sections which have been adopted by the board. It can be understood that an almost infinite number of cross-sections might be prepared, each varying from the others in some small detail of width subdivision. It is not the intention to carry standardization to this extent; the purpose of the work and the object of the board is not so much to obtain strict standardization as to insure greater economy and orderliness in the placing of surface improve-

ments in streets. District surveyors are p submit to the board any cross-sections whic sider more desirable than any of the standa which is subject to the approval of the board

In furtherance of this idea, the city counc ordinance authorizing the board of surveyo such standard cross-sections and providing t

No improvement of any kind for which a shown upon the said plans and cross-sections, plans filed as provided for in section 4 here placed in any street except in the location so p no department or bureau of the city, or publi other corporation, company or individual, sha such improvement in any street without first tained the proper location and the lines and the surveyor and regulator of the district.

The section 4 referred to provides that:

Whenever any street is to be improved by gr ing, paving, repaving, macadamizing or other a facing, or by the planting of trees, if, in the judg Board of Surveyors, the full width of the road confirmed is not immediately required and wil quired to accommodate travel and a temporary the width of said roadway is advisable and w economy of construction and maintenance, the of Surveyors shall direct that a plan be prep approval showing the proposed widths and roadways, footways, and other surface impro accordance with a standard cross-section for a s width, adopted as authorized in section 1 her file in the Bureau of Surveys; which plan, upon the Board of Surveyors, shall be filed in the Surveys as a supplement to the records of th plan and a copy of the same shall be filed with of highways, and the said plan shall be followe all street improvements.

It is provided that if any owner set a cu footwalk not in accordance with a plan of th must reconstruct this improvement, or afte notice the reconstruction will be performed reau of Highways and the cost collected as ment for street improvement.

Whenever the increase of travel makes it d the opinion of the Board of Surveyors, then may have the roadway widened to the full widt

to be done by the Bureau of Highways and the additional new paving "assessed against abutting property where legally chargeable."

In order to carry out the provisions of this ordinance the board of surveyors last November adopted rules calling for the filing in the office of each surveyor and regulator of all standard cross-sections for the various street widths; and that any surveyor and regulator who learns of any street improvement to be made in his district, or who believes that a change in any street plan should be made, shall notify the board of this in writing, submitting a proposed cross-section in case none of those already adopted seems to fit the case. If this recommendation of the surveyor and regulator is approved, he will then prepare a plan following such recommendation, which plan will be submitted to the board and if approved will be filed as the official plan for that street. The surveyor and regulator of each district is also directed to notify the chief of the Bureau of Highways of any violation of any plan so adopted.

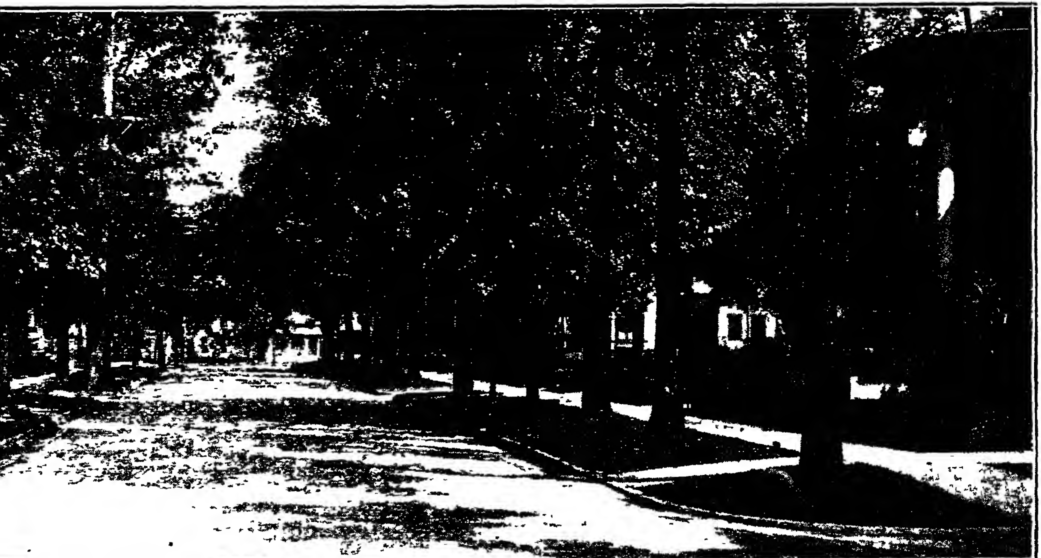
CHAPTER XVI.

STREET CROSS-SECTION

The widths required for sidewalks, roadway, street railway, planting strips, ètc., having been determined for a given street, there still remains the location of these, both horizontal and vertically, with reference to each other. The ordinary arrangement is to place a sidewalk on each side of the street with a roadway betwèen; and the railway tracks, if any, in the middle of the roadway; all symmetrical with the center line of the street. But there may be conditions which would be better met by varying this arrangement, and such variations should be made more often than they are in practice. Some of these have been referred to already.

Where the greatest amount of access to buildings on a block is by vehicles rather than pedestrians, the footway may best be placed in the center of the street, with a roadway on each side extending to the buildings; or the sidewalk may be omitted altogether if the street is a "blind" one or for some other reason there is no through foot traffic. If there are such buildings or a freight yard or dock along one side, the sidewalk on that side may be omitted altogether. Also where there is little use of sidewalk, as in a short local street or "residence park," only one sidewalk may be constructed.

In the case of a steep hillside, with houses facing the street on the upper side only, a sidewalk may be placed on that side only. Where, because of the slope of the ground, one side of the street is much lower than the other, the lower sidewalk may be placed close to the property line, with a narrow planting strip between it and the roadway, or none at all; while the upper sidewalk may be removed some distance from the property line with an intervening terrace, or a wide parked terrace



sy, Barber Asphalt Paving Company.

FIG 99—WELL PROPORTIONED SUBDIVISION OF STREET.

improved by closed view at the end. Henrietta St., Kalamazoo, Mich. Note raised crosswalks, ith sewer inlets beyond them. Also large stone to prevent vehicles "cutting the corner," as they are apt to do where there are raised crosswalks.

may be placed between it and the roadway; the center line of the roadway thus being forced to one side of the center of the street. (Such treatment will be considered further in discussing grades of street cross-section.)

Where the street is narrow and is a minor pedestrian thorofare, one sidewalk may be made sufficiently wide to serve thorofare purposes—say 10 or 12 feet—while the other is made only 4½ or 5 feet wide, to serve only for giving access to abutting property. Where there is a wide parkway in the center of the street, a thorofare sidewalk may be located in this, sidewalks for local purposes only being placed on the sides of the street.

Instead of one roadway at or approximately at the center of the street, there may be streets with no roadway at all, the entire space between sidewalks being occupied by parking, and all teaming to the abutting residences being done through alleys or narrow streets at their rear, as at Venice, Cal. Or there may be two roadways, separated by a central sidewalk, a parkway, a street railway, a railroad cut, a stream, etc. Three roadways are found in some streets, one central one for through traffic and a narrower one on each side, called a "service" roadway, to give access to abutting property, these being separated by parkways or railway tracks. (See Chapter XIV.)

In some cases of steep streets, a narrow roadway winds

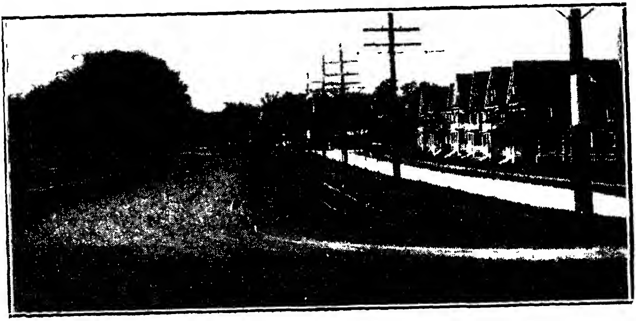


FIG. 100.—STREET RAILWAY TRACKS ALONG SIDE OF ROAD. AUBURNDALE, MASS

FIG. 101.—PARKING SPACE IN MARSHALLTOWN, IOWA. Street widened by taking strip from park. Curbed guard islands with electroliers in parking space.

back and forth from one side of the street to the other in order to reduce the grade; the sidewalks generally running straight up each side, since pedestrians can climb a steeper grade than can horses. In other cases of steep streets the roadway is omitted altogether, and the sidewalk is carried up by steps, or by steps and sl alternating.

Street railways are generally placed in the center of the roadway and at the same grade as the pavement, with from 10 to 11 feet between centers of tracks (15 to 16 feet between outer edges of outside rails). In a business district or a narrow roadway this is always desirable, since vehicles will wish to cross the street at every cross street (and these are close together in the business district), and to use the track space for turning out in narrow streets. Some cities have located the track or tracks near the curb in narrow streets in the business district so as to give a wider roadway for vehicles; but records show that there are more accidents in such streets than where the track is in the center. Philadelphia endeavored to solve the problem by the general practice of placing only one track in a street, the cars moving in opposite directions on successive parallel streets; and this is done to a less extent by several other cities.

In wide streets outside of the business district the railway tracks may be set off from the roadway, by a curb on each side or by running them through a parkway. Where it is possible to plant shrubbery outside of the

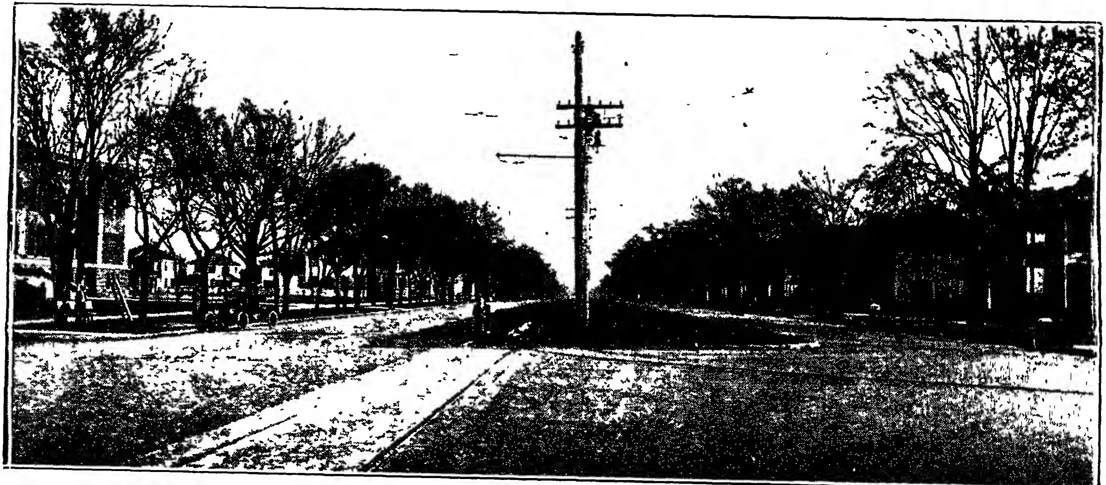


FIG 102.—ELMWOOD AVENUE, COLUMBIA, S. C.

Is 150 feet wide between building lines, with a 6 ft. cement walk 2 ft. from each line, and a 17 ft planting strip or parkway between this and the roadway. Each roadway is 30 ft. wide. The center parking is 40 ft. wide. Reinforced concrete poles in the parking carry wires and trolley wire supports The city is about to plant ornamental trees along the sides of the center parking. The roadways are paved with sheet asphalt.

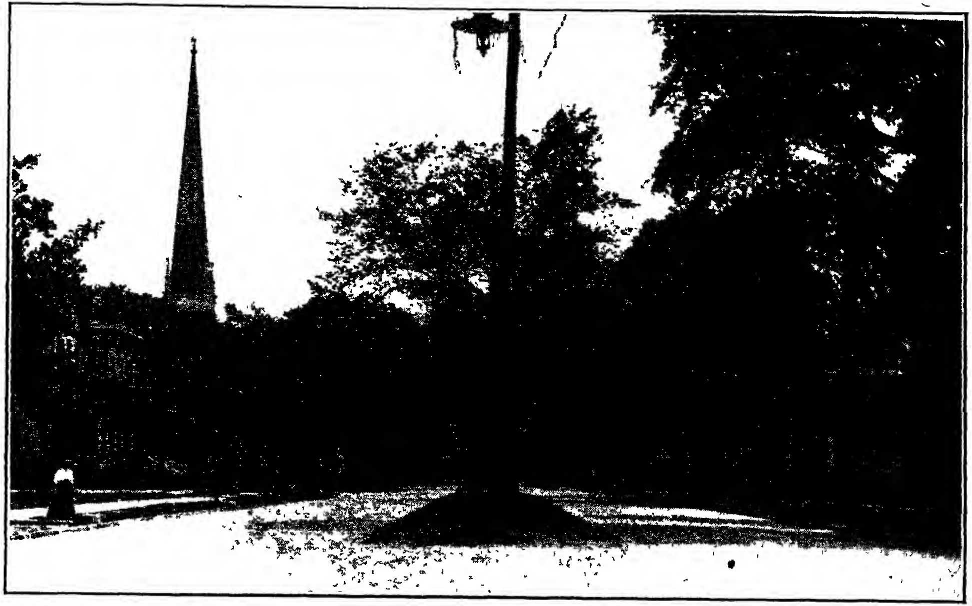
tracks, this decreases the amount of dust and noise from the cars which reach the street on either side and, by hiding the tracks and partially concealing the cars, diminishes the objectionable features of a railway in a residence street or pleasure thorofare. Planting grass on the railway strip prevents dust, but the oil from the motors makes a black streak on the grass in the middle of each track, which is unsightly.

On interurban highways and suburban roads, the tracks are often placed on one side of the street or road. As there is little crossing by pedestrians, this does not appear to increase the danger of accidents, and it leaves a freer roadway for vehicles. It interferes, however, with teams stopping in front of houses on the side nearer the tracks. Placing one track on each side of the road is doubly objectionable from this point of view.

Parkways are generally placed in the centers of wide streets. They may carry a footpath or sidewalk, a roadway or street railway tracks; and the roadway may be so wide as to practically make two parkways. Many cities take advantage of a central parkway to place therein telephone poles, street lamps on poles, fire hydrants, public comfort stations and other public utilities.

A pleasing novelty in the way of parkway arrangement is illustrated by Forest avenue, Toledo, where the parkway is alternately in the middle of the street and as two parkways along the sides; thus closing the vista of roadway in each section by a view of the parkway in the other, and giving the effect of a winding road in a straight street.

Planting strips are generally placed on one or both sides of sidewalks in all but business districts To give room for trees to grow and for maintaining an attractive lawn, the strip should be at least 6 or 7 feet wide, and wider would be better This strip is sometimes so wide as to be practically a parkway, in some cases a narrow path being carried through it in addition to the regular sidewalk pavement The location and proportioning of these strips relative to the remainder of the



Courtesy, Warren Brothers Company.

FIG. 103.—MARKET STREET, WILMINGTON, N. C.

Is greatly improved by the trees in the central parkway. It would be better to make the side planting strips wider, since they are too narrow for the large trees planted in them or to give an attractive appearance to the low terrace on the right hand side. Each roadway could probably stand narrowing a few feet to permit widening these strips.

street is of great importance in securing a pleasing and artistic appearance. Such an effect is produced by Henrietta street, Kalamazoo (see page 149); and an even better one, in our opinion, by Ferry avenue, Detroit. (See Fig. 79, page 120.) The appearance of the former, however, is improved by the closed vista.

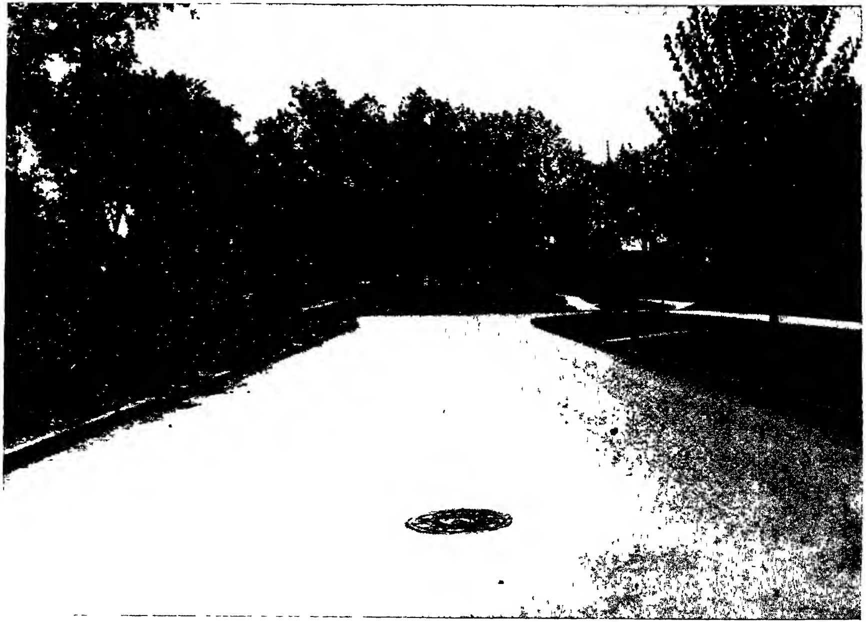
The planting strip is sometimes omitted on the outside of narrow sidewalks, but these are placed next to the roadway and a wider planting strip left inside the sidewalk. Some cities prefer this location, the abutting properties thus appearing to have wider lawns, and the houses being farther removed from sidewalk traffic. Also, since the shade trees, if there are any, are inside the walk, it is more practicable to light both roadway and sidewalk with the same street lights. Where the yards are considerably higher than the sidewalk, this location furnishes a wider space in which to terrace down from one to the other.

On the other hand, when the roadway and sidewalk pavement are separated only by a curb, pedestrians receive more dust and splashed water from the roadway,

Courtesy Barber Asphalt Paving Company

FIG 101—LEOMINSTER ROAD, FITCHBURG, MASS

Already narrow sidewalk, obstructed by poles Drive-



Courtesy, Ohio Quarries Co

FIG 105—PARKED STREET, FOREST AVENUE, TOLEDO, O.
A pleasing effect is produced by alternating side and central parkways.

are in more danger from vehicles, and are less shaded by trees; driveways across the sidewalk require a depression of the paved strip, which is not necessary when the rising slope can occur in the planting strip; stepping from sidewalk to roadway at street corners is more difficult, and also more dangerous from teams turning into the intersecting street; fire hydrants, hitching posts and other posts which must be or generally are placed along the curb cause much more interference with traffic, and

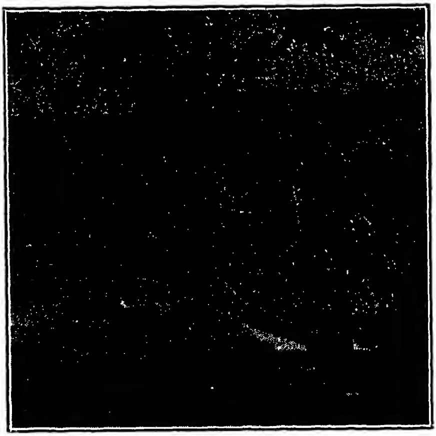


FIG 106—STUART AVE, OUTREMONT.
Notice care taken to preserve trees in Outremont; the pavement winding through the sidewalk space, while the tree which some cities would remove (it stands too high to leave in the gutter) is walled up, even though narrowing the roadway at this point.

in the opinion of the majority, we believe, the effect of the street as a whole is not so pleasing.

In locating the several subdivisions of a minor street where trees already exist which are suitable for use as shade trees, every effort should be made to use the trees rather than to remove them. The sidewalk pavement

the pavement divides, passes around each side of the tree and reunites beyond; and even the roadway may be divided by a fine or historic tree in its mid-width. But trees should not be left standing in the gutter, for they not only interfere with the drainage, but are sure to be barked by wheels and probably gnawed by horses and have a generally dilapidated appearance, and are dangerous to vehicles. A tree which stands outside the general curb line may be saved by carrying the gutter around it with a long sweeping curve, walling around the tree to protect it, if necessary.

When space can be found or made, parking places for automobiles should be secured within a block or two of the business center or of each of the main streets thereof. This may be effected by narrowing sidewalks which are unnecessarily wide: by moving back a sidewalk along a park; by making a street a one-way street and assigning one side of the roadway for parking; or sometimes by making over a central parkway into a parking place. The most satisfactory location, probably, is a strip down the middle of a roadway.

As a long touring car is about 16 ft. long over all, and some clearance should be left at each end, an area 20 ft. wide should be provided for a central parking space. Where parking is against one curb and the cars stand at an angle with the street, 15 or 16 feet may suffice. In any case, to indicate the boundary of the parking space and also to protect the parked vehicles from moving ones, an elevated "island," a heavy railing or a row of heavy posts should be set across each end of the area, parallel to the axis of the vehicles when parked.

CHAPTER XVII.

STREET CROSS-SECTION

(Continued)

From the point of view of traffic, transverse grades are undesirable on either sidewalk or roadway and are inadmissible in a street railway track except at curves. If it were not for rain water, roadways would probably be made flat between curbs, and sidewalks between curb line and property line, except as the grade of the original surface made some cross-slope necessary, or at least desirable.

If a roadway were made with a horizontal cross-section, and could be constructed and afterward maintained in this condition, water would flow with the longitudinal grade of the street at equal depth over the entire width, this depth increasing as the water accumulated toward the foot of the slope. There it would be necessary to provide some means for removing the water from the surface, either by placing an inlet grating across the entire roadway or by giving the roadway a crown at the foot of the slope and thus diverting the water toward inlets at the curb on either side.

This construction has been proposed, and approximated in practice, but is very infrequent. It is objectionable in that, on the lower stretch of each grade, the amount of water flowing in the roadway causes inconvenience to both horses and vehicles and to pedestrians crossing the street. In case of macadam streets, water flowing over the surface in this way will erode such surface; and especially after incipient ruts or other depressions have formed, it will follow and increase such depressions. In all streets the greater part of the wear comes at the center, and a roadway originally made flat will

it will cause the most inconvenience to traffic rather than the least.

It is therefore almost the universal practice to give a crown to a roadway. The matter is frequently overdone, however. The crown should be just sufficient to shed the water to the sides of the roadway, since the greater the crown the greater the inconvenience to traffic and the more such traffic and the wear resulting therefrom are concentrated in the center of the roadway. The more uneven the surface, the greater the crown or cross-slope which is necessary to prevent water standing in any depressions therein. Also the greater the injury which would be done by water flowing along the surface, the greater the necessity for carrying it directly to gutters which are adapted to removing it without injury to its surface. For both these reasons, macadam, gravel and other road surfaces which rely upon damp earthy matter for binding the coarser aggregate, should have a greater crown than is required by asphalt, brick or other block pavements, concrete and other pavements which are little affected by water and which are quite smooth when properly laid.

As explained above, a gutter carrying water down the middle of a roadway generally is considered objectionable because the greatest amount of moving traffic is concentrated here. There may be cases, however, such as alleys or other narrow streets without sidewalks, in which this form of cross-section is preferable to crowning the street. Where the street is dished, the slope toward the central gutter is desirable for the same reason and should be the same in amount as that from crown to side gutters.

There are two general forms of cross-section employed in crowning a roadway; one, by providing a straight slope from each gutter to the crown, the slopes usually being connected at their intersection by a flat curve; the other, by giving the entire cross-section the form of a curve extending from gutter to gutter. The former has the advantage that the slope near the gutter is no greater than on other parts of the street, and therefore there is not the tendency for traffic to concentrate at the center which is caused by the steeper slopes at the sides occa-

sioned by a curve cross-section. On the other hand, the steep side-slope of the curve cross-section serves to concentrate surface water into a narrower gutter channel than does the flat slope unless the gutter on the latter cross-section be formed by a depression below the general slope of the cross-section. Another objection to the straight slope is that, as the pavement wears, and especially on streets where there are two continuous lines of traffic and consequently where the wear is greatest, this wear ocurs a few feet on either side of the crown and results in a dishing of the slope at these points which, if it becomes at all considerable, will hold the water and prevent its reaching the gutters.

If the cross section is made curved, the most common practice is to make this curve a parabola, chiefly because of the ease with which it can be laid out; one law of the parabola being that the distance that the curve at any point is below a tangent to the crown varies as the square of the distance of such point from the crown. In staking out such cross-section, therefore, it is only necessary to know the distance from crown to gutter and the depth of the gutter below the crown, and the depths of any intermediate points below the crown will then be to the depth of the gutter as the squares of their respective distances from the crown. In the curved section, a considerable amount of wear fairly well distributed over the quarter points or haunches, (the portion approximately one-half way between crown and gutter) will still leave sufficient slope toward the gutter to permit the water to flow off.

As already stated, the amount of elevation of crown above gutter should vary with the material of which the roadway is constructed. Byrne, in his "Highway Construction," gives the following as the ratio of rise to distance from gutter to gutter: Earth, 1-40; gravel, 1-50; broken stone, 1-60; stone blocks, brick and asphalt, 1-80, wood blocks, 1-100.

Andrew Rosewater some years ago advocated the following rule for smooth streets like asphalt: crown $= \frac{W\ (100-4f)}{5{,}000}$. For macadam, stone and other less

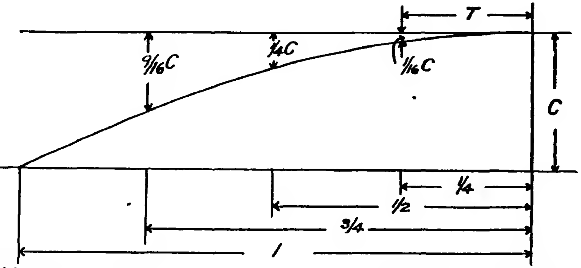


FIG. 107—CALCULATION OF PARABOLIC STREET CROSS-SECTION.

C is difference in elevation of crown and gutter. The horizontal distance between the two is divided into four equal parts, and the drops below the crown elevation are the fractional parts of C which are given, obtained by squaring the fractions at the bottom of the diagram.

The lower cut represents a roadway cross-section with the vertical scale exaggerated ten times. The solid lines show the methods of crowning, one by a parabola, the other by straight lines connected by a curve. The dotted lines show the result of the same amount of wear—a maximum of ¾ inch—on the quarter points of each surface, and how depressions form in the straight-line cross-section.

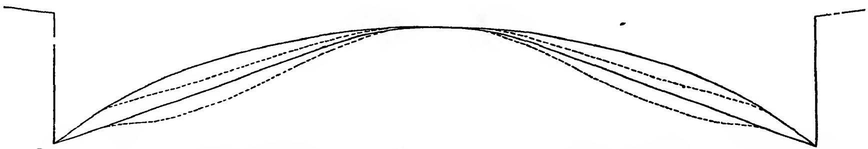


FIG. 108—USE OF PARABOLA AND OF STRAIGHT LINES IN CROWNING ROAD COMPARED.

smooth street, crown $= \dfrac{W\ (100-4f)}{6{,}000}$; in which W is the distance between curbs in feet, and f is the feet fall per 100 feet of street. It seems to us that this gives too much crown for asphalt and other hard pavements and not sufficient for macadam. It will be noticed also that it would decrease the crown as the grade increases. From the point of view of shedding water to the gutter as quickly as possible, the reverse of the rule should be followed, since the steeper the grade the greater the tendency for the water to flow down the street rather than across it and to follow ruts or any longitudinal depressions in the roadway. Presumably Mr. Rosewater's aim, however, was to accommodate traffic and make it easier for teams to climb a steep grade by winding from side to side.

Crowns as flat as and even flatter than 1 in 100 have been used for asphalt streets in New York; 1½ in 100 in Wabash Ind.; 1.4 in 100 plus .03 feet in Champaign, Ill., and 1¼ to 1½ in Indianapolis.

These ratios give the crown in terms of the width between curbs, with the assumption that the crown will be in the middle of the roadway. This location of crown is the best construction, but is not always practicable, and a better plan seems to be to express the crowning in distance from gutter to crown of roadway, wherever the latter may occur; in which case this distance is taken as one-half that given in the above ratios. The amount of crown will be different on the two sides of the street when the gutters are not at the same level, which is frequently the case; which is another reason for giving crowning in terms of distance from gutter to crown rather than total width of roadway.

On side hills it sometimes seems necessary that one sidewalk be made considerably lower than the other if the amount of excavation on one side and of fill on the other, and also the relative elevations of building lots and sidewalks, are to be made practicable. In such cases it is of course still possible to give both gutters the same elevation by using a very shallow curb on the downhill

side and a very high one on the uphill. (Further discussion of this will be given at length in the next chapter.) An alternative is to leave one gutter higher than the other. When this is done, if the roadway be given the same general slope from each gutter toward the crown, the crown will then be thrown toward the uphill gutter. Some would always place the crown in the middle of the street, keeping the rate of slope to the lower gutter below a certain maximum and that from the crown to the upper gutter above a certain minimum. The latter plan probably gives a somewhat better appearance to the street, but the former would seem to make better provision for both traffic and cross drainage. In either case, however, the slope from crown to lower gutter should be kept within a certain limit beyond which it would be inconvenient for vehicles. Such a cross-slope probably should never exceed one foot in twenty-five for asphalt or other smooth pavements, nor one in twenty for any other pavement; and thirty-five and thirty respectively would be preferable.

If an asphalt roadway be 30 feet wide and one gutter 1.2 feet higher than the other, this would give a continuous slope from one gutter to the other and would set a limit to the amount of difference in elevation which is permissible between the two gutters.

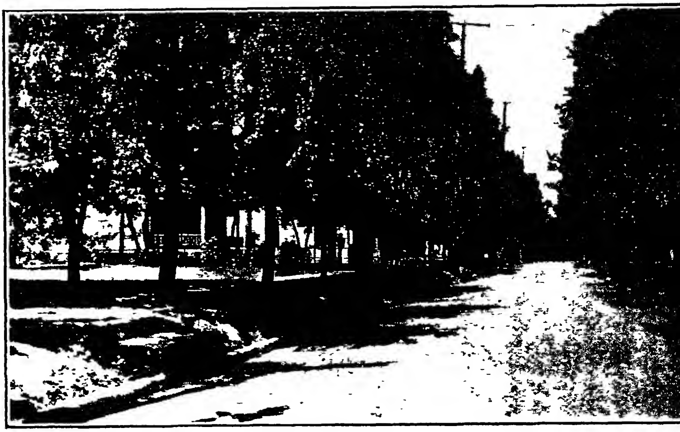
CHAPTER XVIII.

STREET CROSS-SECTION

(Continued)

In exceptional cases the water flowing off of the sidewalk may be allowed to pass on to the lawns of private property, where it will be absorbed; but in the majority of cases it is desirable that all water falling outside of the property line be carried to the street gutters. This requires a cross-slope of sidewalks. As in the case of roadways, this slope should be as little as is necessary to carry all water with certainty to the gutter, since it is objectionable to traffic using the sidewalk. The smoother the sidewalk the less the slope which is necessary. New York some years ago established by ordinance a cross slope of 1 inch in 5 feet. Pittsburgh a slope of 1 inch in 4 feet for concrete and flag stone, and 1 inch in 2 feet for brick. One inch in 5 feet is probably about the flattest and one inch in 2 feet about the steepest which should be given to any sidewalk.

The amount of water flowing on the grassed or otherwise planted strips along either side of the paved portion is probably never sufficient to do any damage, and is therefore unobjectionable. For some incomprehensible reason many sidewalk builders construct, and cities permit them to construct, the paved portion of the sidewalk as low as or even lower than the planting strips on either side of it, which results in the inability of the water to flow off of the paved strip, and turns each strip into a river or a lake, depending upon its longitudinal slope. There may be some excuse for keeping the planting strip which is on the inside of the walk on a level with the same, and permitting the water from such strip to flow across the walk to the other strip. But under no condition should the outer strip be higher than the paved portion, and it is very desirable that it be about a



Courtesy, Barber Asphalt Paving Co.

FIG 109—AVON STREET, FLINT,

In Avon street Flint, the sidewalks are at about the sa
pressed about two feet, and a fairly wide terraced parkwa
ment and roadway Here the trees are on the roadway side
have been placed a little further from the side walk paveme
the curb and the trees well back from the same, however, per
poles and wires with trees When full grown, these trees w
the street

sidewalks are at about the same level, but the roadway is de- a fairly wide terraced parkway and curb separate sidewalk pave- trees are on the roadway side of the sidewalk, but would better her from the side walk pavement. Placing the telegraph along ck from the same, however, permits a minimum of interference of When full grown, these trees will form a handsome arch across

Co.

—UNDERCLIFF AVENUE, YONKERS, N. Y.

half-inch lower. Moreover, sidewalk paving is almost certain to settle more or less as the cinder foundation under it consolidates; while on the other hand, ground which is sodded tends to rise through the action of roots and frost and the gradual collection of dust and dirt held by the grass. The result is that, if a sidewalk pavement be laid originally at the same grade as the adjacent soil, a year or two will find the sod which has grown thereon stand higher than the pavement and thus prevent the draining of the latter. The pavement should always be constructed at least an inch higher than unsodded soil and at least a half inch higher than soil carrying well developed sod; and it is better to increase each of these by a half-inch.

A sodded strip needs a greater cross-slope than a pavement for carrying off a given amount of water; but if the side adjacent to the pavement is kept ½ inch to 1 inch lower than the pavement, slight temporary accumulation of water on the sodded strip will not be especially objectionable. There should, however, be some fall

Courtesy, Granite Paving Block Manufacturers' Association
FIG 111—SIDEWALK ELEVATED ABOVE STONE CURB

FIG 112—CURB DEPRESSED AT CROSSING.

across the entire section of the sodded strip in order that no water may stand there permanently, and it is desirable to give the sodded strip an even greater fall than that required for a concrete or flag pavement. If a curb is provided, this would place the top of the curb lower than would be called for if the sidewalk pavement were extended out to the curb; or else the sod at the curb would be lower than the top of the latter. If the curb is of stone, it would probably be reset in any event when the entire sidewalk was paved, as it would probably have got more or less out of line or grade in the interval; and in resetting, it could be raised to agree with the new pavement. In the case of a low concrete curb, or of a stone curb which it is not desired to reset, the concrete sidewalk pavement, when extended to the curb, can be carried higher than the top of the curb to a point about one half way across said top, and there be finished with a bevelled edge; which construction is sometimes adopted solely to provide for expansion of the concrete sidewalk without overthrowing the curb.

The purpose of the curb is to keep the water in the gutters from overflowing the sidewalk, to prevent vehicles from riding on the sidewalk, and to give a finished appearance to the street. Where the aim is to give a rural appearance to the street, the curb may be omitted and the outer sidewalk strip sloped down to the gutter, such slope being sodded, and the gutter being sodded also or else paved with cobble stone or other material. In this case the planting strip usually carries trees which suf-

Courtesy, Ohio Quarries Co.

FIG 113—LANCASTER AVENUE, SYRACUSE, N. Y.

The treatment of a very steep and high bank is seen at the left of the view of Lancaster Avenue, Syracuse. Here the sidewalk was graded down practically to roadway level, with a long flight of steps leading to each house.

ficiently protect the sidewalk from the encroachment of vehicles.

SIDEWALK ELEVATIONS.

Whether or not a regular curb is provided, the elevation of sidewalk above gutter and roadway should be such that the sidewalk will not be flooded by any rains except unusual downpours. This will depend not only upon the intensity of rainfall in the section of the country under consideration, but also upon the slope of the gutter and the frequency with which the water flowing in the gutters is withdrawn therefrom into sewers, streams or other channels. Where sewer inlets are numerous, a 4-inch curb has been found to meet requirements. With inlets at intervals not exceeding 500 feet and grades not flatter than 1%, a 6-inch curb is perhaps safer and is the more general practice. In at least one or two southern cities which are not provided with storm sewers and which have occasional heavy downpours, 10-inch and even 18-inch curbs are considered necessary and are provided. Aside from the cost of construction, the prin-

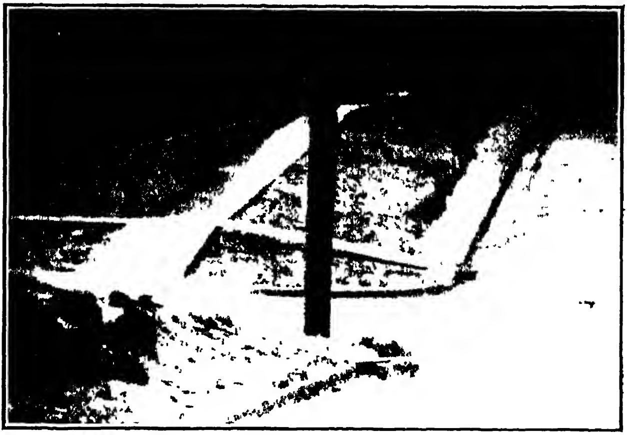


FIG. 111. INCLINES FROM ELEVATED SIDEWALKS AT CROSSINGS

Concreted slope as substitute for high curb. Prospect Street,

cipal objection to these deep gutters is the difficulty of passing from sidewalk to roadway at street intersections. In Houston, Texas, where such high curbs are found, the common practice is to place a step from sidewalk to roadway at each street crossing. In some cases, instead of a step, the sidewalk is sloped down to the roadway for about 5 feet back from the same at each crossing, the curb being depressed at such points.

Where there is considerable cross-slope to the street, especially in residential sections where the houses are set back from the street line, the yards and houses on one side of the street may of necessity be several feet higher than the roadway. Under such conditions there are in general two alternatives. One is to place the sidewalk 6 or 8 inches above the roadway, as would be called for

FIG. 115—TERRACED PLANTING STRIP, WITH CURB.

by the principles just discussed; thus possibly leaving the house and yard at a considerable elevation above the sidewalk. The other alternative is to place the sidewalk more nearly on a level with the house (it is always desirable to have the house at least 2 or 3 feet higher than the sidewalk),. thus placing the sidewalk several feet above the roadway. The latter plan is extremely elastic, however, and permits the placing of the sidewalk at any elevation greater than 6 or 8 inches above the roadway. It is generally much more economical in cost of grading than the former.

Whichever of these two plans is adopted, it becomes necessary to place either a terrace or retaining wall between the sidewalk and the yard level on one side or

FIG. 116—RETAINING WALLS FOR DEPRESSED SIDEWALK.

roadway on the other. A curb is in itself a small retaining wall, and where the sidewalk is placed some distance above the roadway, the curb may be merely carried higher. The retaining wall need not, of course, be carried to the full elevation of the land above it, but only to such point as will permit of a low terrace on a flat slope extending back from the top of the wall.

Perhaps the most common plan, because the cheapest, is to connect the sidewalk with the land above or roadway below by a terrace or slope which is sodded. In

FIG 117—STEPS USED TO DESCEND FROM ELEVATED WALK TO ROADWAY

FIG. 118—WASHINGTON STREET, EAU CLAIRE, WIS.

Washington St., Eau Claire, was laid out on level ground, in the foreground, but in the background the left curb gradually increases in height until it becomes a retaining wall about four feet high as it swings into the hill at the turn. The shade trees in the foreground are located on the further side of the sidewalk pavement, while in the background they are next to the curb. The appearance of the latter seems to us preferable, as it produces more of an arch effect. But if all were in either one position or the other it would greatly improve the appearance of the street.

nine cases out of ten these slopes are made too steep, a great many of them being as steep as 1¼ or 1½ to 1. It is exceedingly difficult to grow and maintain sod on a slope as steep as this, and the cutting of the lawn on such slopes is a difficult matter. It would be much better to make such slope at least as flat as 2 to 1, and 3 to 1 would be a better maximum to establish. Given such a maximum, a terrace of say 3 to 1 could be carried from the yard level to the line of the sidewalk (or 18 inches to 2 feet from the inner edge of the pavement, and the remaining drop be made by retaining wall.

Where there are shade trees of any size, either between sidewalk and roadway or sidewalk and house, it is desirable to leave the ground surface around these trees at its original level, using either terrace or retaining wall as may be necessary to accomplish this. This presence of shade trees may determine where the sidewalk should be placed in plan and whether a few inches or several feet above the roadway level.

Too many engineers and street planners set up a hard and fast rule that the sidewalk shall be just so many inches above the roadway, and have carried out such rule regardless of any existing conditions as to ground surface, trees or anything else. There are scores and hundreds of cases where raising a sidewalk several feet above the roadway would have saved much of the cost of grading, have preserved valuable shade trees and have given equally as good if not a better appearance to the street, all of which have been sacrificed to rigid and foolish adherence to an unnecessary standard.

CHAPTER XIX.

STREET CROSS-SECTION

(Continued)

On hillside streets it is not possible to construct the roadway and sidewalks at the ground level; part or all must be either cut or fill, or part cut and part fill. The last is generally preferable, but in uneven ground the street will often pass alternately between mostly cut and mostly fill. Because it is rather expensive to compact a fill so that there will be no future settlement (but this should be done wherever there is to be a pavement, either sidewalk or roadway), and because it is much more desirable that a house be several feet higher than the roadway than that it be several feet lower, the grading should consist of excavating to a much greater extent than of filling. It is especially desirable that as little as possible of the roadway subgrade be in fill, because of the injury which would be done to roadway pavement by settlement.

In the illustration are shown a number of sections of hillside streets, in each of which the roadway subgrade is entirely in cut and the lower sidewalk is in fill. In number 1 we have a "lopsided" street, the crown coming near the left curb. In the second case the roadway slope is continuous from the left curb to the right. In the third, even with the continuous slope the left sidewalk is not sufficiently high, and a double or stepped curb is employed. In the fourth the ground slope (represented in each case by the dotted line) is greater and it is thought desirable to keep the sidewalk elevated near the original surface, to economize in excavation, preserve shade trees or for some other reason, and a retaining wall is substituted for the curb. In the fifth, the ground slope is the same, but the sidewalk is lowered

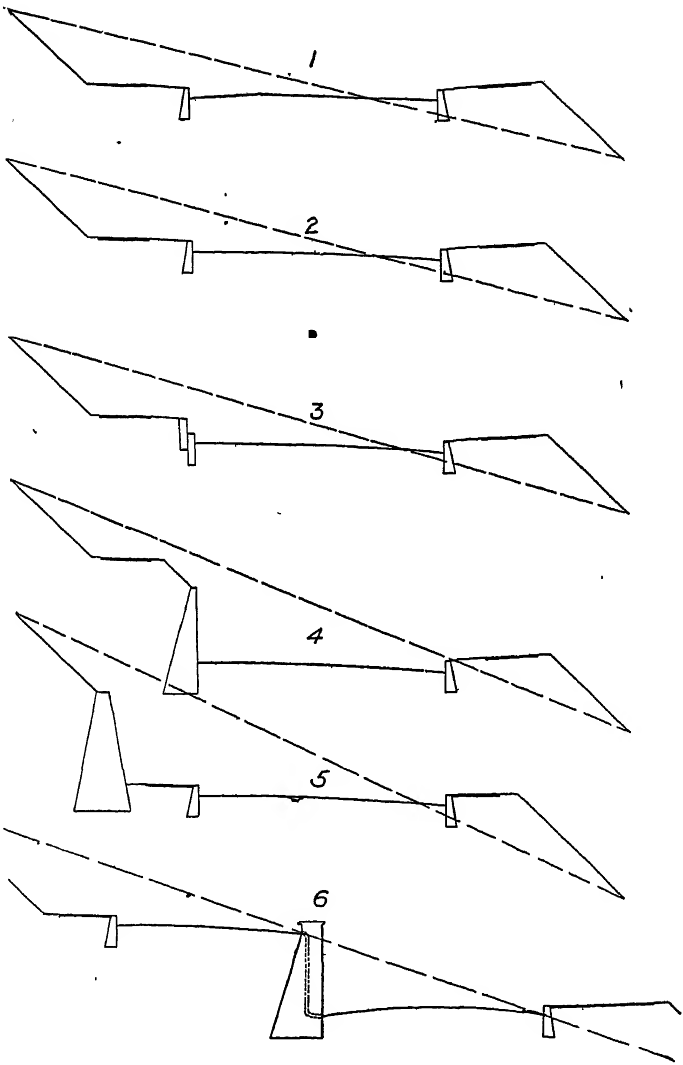


FIG. 119.—SECTIONS OF HILLSIDE STREETS.

In this last case the fill on the right side of the street is reduced by narrowing the sidewalk space and placing the sidewalk pavement next to the curb. It is placed next to the curb on the left hand also, in order to introduce a sodded strip between it and the retaining wall, which improves the appearance of the street, and makes it pleasanter for those using the sidewalk.

The elevated sidewalk, number 4, has several advantages over number 5. It is cheaper to construct. It reduces the climb from the sidewalk to the houses which it serves. It is more agreeable to walk above the roadway and with the terraced yards but little higher than the sidewalk, than to have a retaining wall or a steep, high terrace depriving the pedestrian of any view on that side. It permits of retaining any trees which may have existed before grading. In a business section this con-

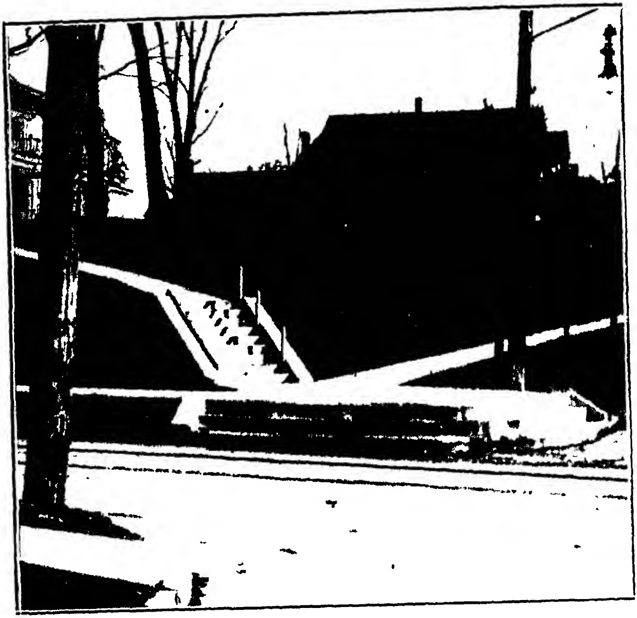


FIG 120—STEPS FROM ELEVATED SIDEWALK, SYRACUSE, N Y

FIG. 121.—STEPS FROM ROADWAY TO SIDEWALK; ALSO PRIVATE STEPS FROM HOUSE TO ROADWAY, SYRACUSE, N. Y.

struction is not desirable because it interferes with crossing the street and with entering and leaving vehicles at the sidewalk level; but in such sections the buildings themselves will generally be set nearly at the roadway level, the entire lot being graded down.

The principal objection to the elevated sidewalk is the difficulty of crossing intersecting streets. This must generally be done by introducing either an incline or a flight of steps at each crossing. The former is perhaps preferable where the sidewalk is not too high; but the slope should not exceed ten per cent, and five per cent would be preferable; and with a sidewalk elevated considerably and short blocks, the sidewalk would become a series of rising and falling inclines. Several very neat arrangements of steps are to be found in Syracuse.

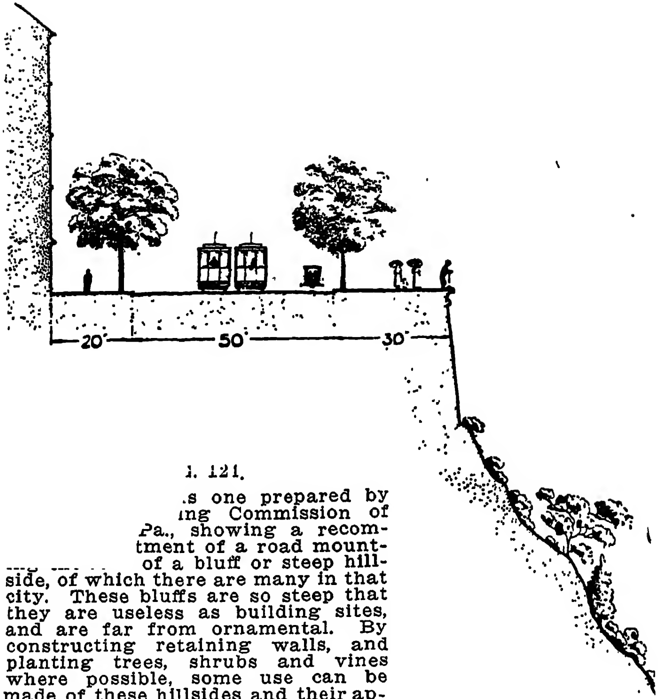
One of the difficulties of hillside street construction is that of grading the cross-streets. These would naturally follow the ground surface, shown by the dotted lines; but at the street intersection the cross-street as

Courtesy Warren Brothers Co.

FIG 122.—NORTH DRIVE OF BEACON STREET, BROOKLINE, MASS.

Courtesy Warren Brothers Co.

FIG. 122.—NORTH DRIVE OF BEACON STREET, BROOKLINE, MASS.



1. 121.

.s one prepared by
ing Commission of
Pa., showing a recom-
tment of a road mount-
of a bluff or steep hill-
side, of which there are many in that city. These bluffs are so steep that they are useless as building sites, and are far from ornamental. By constructing retaining walls, and planting trees, shrubs and vines where possible, some use can be made of these hillsides and their appearance can be greatly improved.

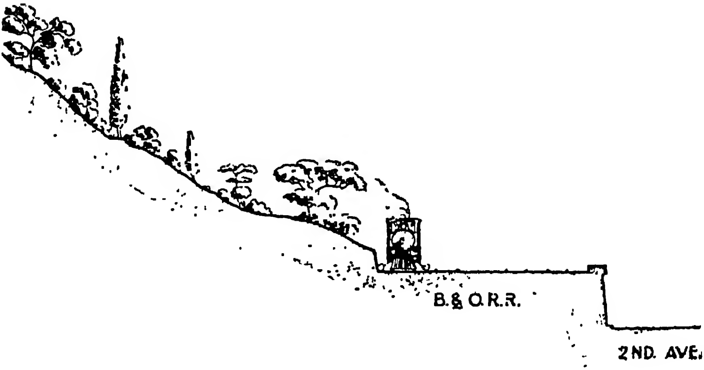
may have been so steep that the grade so caused would be excessive. Moreover, the considerable elevation of houses above roadway of a hillside street presents some objectionable features. To meet these conditions, several cities have constructed two-level streets, as shown in section number 6; the roadway being divided into two parts constructed at different elevations and separated by a retaining wall. The cross-street is broken in grade at this dividing wall, and travel along it can be continued only by turning along the hillside street to the point where the two sections of the roadway unite, and retracing the route along the other section.

This is applicable, therefore, only where the hillside street is a main thorofare, or rather where the cross-street is not one.

In a few cases (see the view of Beacon street, Brookline) the two levels are separated by a terrace or slope rather than by a wall. This requires excessive width of street and is applicable to special cases only.

Where the surface slope is so steep that no practicable grade for a cross-street roadway seems obtainable, foot traffic may still be accommodated by steps, as we have suggested before. Where the cross-street is the principal one, the steep grade which would be caused by following the ground surface is sometimes avoided by a viaduct, either sloping to a lower level or carried practically level across a valley. In either case, a part at least of the viaduct at each end is generally a fill confined between retaining walls. Buildings at the ground level would therefore require a sidewalk and roadway carried along the surface outside of each of these retaining walls, forming three sections of s
one on each side of the higher viaduct.

In either of these cases, the roadways may each be crowned and drain to gutters on each side, or may slope to one gutter on either the inside or outside of the road-



way. Where the upper level is comparatively short, as in the Chattanooga illustration, the surface water may follow the gutter until it reaches the junction with the lower roadway; but if the upper road is long or level, inlets may be placed along the outside and discharge through pipes built in the retaining wall either onto the lower roadway, or preferably directly into the sewer.

Where the ground is very steep, the problem may not be complicated by cross-streets, since it would be impracticable to construct them on such steep grades. But the construction of the hillside street itself may present difficulties. Such a condition is found in the case

FIG. 125.—DOUBLE OR STEPPED CURB IN COLUMBIA, S. C.
Made necessary by lowering the grade of the roadway after the post office (the building shown) was constructed.

of a street rising along the face of a bluff. The construction of such a street is illustrated by the sketch of a Pittsburgh street held in place by a retaining wall. Unless such a street is near the top of the bluff, there probably will be no building on either side of it, but the upper side of the street will be excavated out of the bluff. In some cases, instead of a retaining wall and earth fill, the outer side of the street is carried on a steel floor system supported by steel columns. This is especially applicable where it is difficult to secure a solid footing for the wall which will enable it to take the thrust of the fill.

FIG 126—WEST 215TH ST., NEW YORK NO ROADWAY.

CHAPTER XX.

MOTOR TRUCKS AND STREET GRADES

While in laying out a system of streets in a hilly country it is impossible to avoid grades, there will often be two sections separated by a hill or ridge which may be connected either by a street running around the hill or by a more direct one over it. The former will necessitate an increase in length due to the indirect course and the question arises as to whether the lower speed and the reduction of the load required on the steeper grade of the direct route are more than offset by the easier grade of the longer route. Assuming such conditions as may be encountered in actual practice, the extra distance that can be traveled economically may be computed.

In making these calculations, we will consider only motor vehicles; and, since practically all pleasure cars are so high-powered in comparison to their weight that they are able to climb grades of 8 or 10 per cent at the same speed that it is safe to travel in city streets, we need to consider only commercial vehicles.

In computing the extra distance that the truck might travel economically, we will assume on the direct route a hill one mile long, paved with granite blocks. We will consider the effects of grades of 3 per cent, 6 per cent and 8 per cent. We will assume that the descending grade will balance in time, etc., an equal distance on the level.

The traffic resistance due to granite block pavement varies according to the condition of the pavement, but an assumption of 40 pounds per ton, or 0.02, is fair. Resistance due to grade will vary with the per cent of grade, but will be 0.03 of the total weight for a 3 per cent grade, 0.06 for a 6 per cent grade and 0.08 for an 8 per cent grade. The total resistance will be the sum of these two resistances and will be 0.05 of the weight for the 3

For reasons for making the above calculations, see "Practical Street Construction," Chapter VI, pages 56 and 57.

per cent grade and 0.08 and 0.10 respectively for the 6 per cent and 8 per cent grades. We will consider the detour street to have the same pavement, or any similar one offering the same tractive resistance. (It might be easier to climb a 3 per cent grade than to use a heavy earth road on the level.)

We may assume as an average truck, a 2-ton truck, weighing 9,600 pounds fully loaded; and a 5-ton truck, weighing 18,000 pounds fully loaded, as a type of the heaviest motor truck. A typical 2-ton truck as made at the present time has a 4-cylinder motor of 4-inch bore and 5½ inch stroke. Under the standard formula for horsepower

$$H. P. = .4B^2N = 25.6$$

where B is the diameter of the cylinder and N the number of cylinders. Gear reduction ratios vary for the different makes of trucks, but the following may be assumed as an average gear ratio (crank shaft to rear wheels): High speed, 7¼ to 1; intermediate, 13 to 1; low and reverse, 30 to 1. Wheel diameter for this size of truck is quite uniformly 36 inches. Where road conditions permit the engine to attain full speed permitted by the governor, speed on high gear will be about 15 miles per hour, on intermediate 8.5 and on low 4 miles per hour. Average speeds will not, of course, be as great, but may be assumed at 10.5 miles for high speed, 6 for intermediate and 3 for low speed. Under heavy load, this speed would be reduced somewhat.

We then have for the 2-ton truck:

B (bore of cylinder)	= 4	W (total weight)	= 9600
S (stroke)	= 5½	D (wheel diameter)	= 36

R = gear ratio

For a 3 per cent grade, the tractive resistance (TR) = 0.05

In order to find R, the gear ratio necessary to climb a given grade under full load, we may use Myers' formula for the tractive force:

$$TF = \frac{28.2\, B^2 SR}{}$$

$$.05 = \frac{28.2 \times 4^2 \times 5\frac{1}{2} \times R}{9600 \times 36} = \frac{155.1R}{21{,}600}$$

$$R = \frac{1080}{155.1} \doteq 6.9+$$

Since the high speed gear ratio is $7\frac{1}{4}$ to 1, the truck could just make the hill on high speed, though the speed would probably be cut down somewhat below the average mentioned above, since under heavy load motors will not fully develop high speed. Consequently there would be little advantage in making a detour to avoid a 3 per cent grade.

In calculating for the 6 per cent grade, the same method would be used, and solving, R is found to be 11.2. This necessitates dropping into second speed, where the average speed would be about 6 miles per hour. At this rate it would require 10 minutes for the ascent, during which time the car could travel on high speed about $1\frac{3}{4}$ miles on the level. It would therefore appear to be economical to make a level detour which would be $\frac{3}{4}$ of a mile longer than the hill route; and possibly more, considering the extra strain and wear on the machine.

Following the same method for the 8 per cent grade, R is found to be 14 and the driver would be obliged to use low speed (the gear ratio for second speed is 13 to 1) and the speed would be about 3 miles per hour. At this rate it would require 20 minutes to climb the hill, during which time the truck could make on the level, at 10.5 miles per hour, 3.5 miles. In this case, theoretically, a detour 2.5 miles longer would be preferable to climbing the 8 per cent grade one mile long.

It is also possible to compute the grades at which a 5-ton truck of standard construction and power, fully loaded, will have to change gears; which calculation might be used for deciding upon ruling grades for a road, and the location imposed thereby. Assuming the following: $W = 18{,}000$ $D = 40$ $B = 4\frac{1}{4}$ $S = 6$ high speed $R = 8$; intermediate, 17; low, 36. Top speed on high gear is 14 miles per hour, on intermediate, $6\frac{3}{4}$, and on low $3\frac{1}{2}$ miles per hour. By Myers' formula and for high gear.

$$TF = \frac{28.2 \times (4\tfrac{3}{4})^2 \times 6 \times 36}{40 \times 18{,}000} = .04\tfrac{1}{4}$$

This result is made up of traffic resistance as well as grade resistance. The former is equal to 0.02 and the latter therefore equals 0.02¼, corresponding to a 2¼ per cent grade, the highest the truck could climb on high speed. Solving for second speed by using 17 in place of 8 in the last equation, we find 7 per cent to be the heaviest grade that can be climbed on second speed; grades over this requiring the use of low speed.

From the same formula it is possible to determine the theoretical trailer loads that can be hauled in addition to the body or carried load, and the grades on which these can be handled. This formula, however, usually gives rather high results and a better and more generally used one for average motor trucks is:

$$P = \frac{5.18364\ B^2\ S\ N\ R}{D}$$

where P is tractive power and N the number of cylinders. Substituting the values for the 5-ton truck given above,

$$P = \frac{5.18364 \times 4.75 \times 4.75 \times 6 \times 4 \times 8}{40} = 561$$

which is the tractive power on high gear. With a weight of truck and load of 18,000 pounds, no grade, and a road resistance of 40 pounds per ton, the effective tractive power left for use on a trailer is $561 - 360 = 201$. At 40 pounds per ton, this would overcome a resistance of about 5 tons combined weight of trailer and load. By using low gear ($R = 36$), $P = 2526$. With this gear, the truck load of 18,000 pounds and a trailer load of 10,000 pounds, the grade that could be negotiated would be

$$2526 = (18{,}000 + 10{,}000) \times (.02 + g)$$
$$g = 7 \text{ per cent.}$$

By the methods employed in other parts of this article, the distances economical to detour in order to avoid grades can be computed for the trucks when equipped with trailers.

CHAPTER XXI.

STREET GRADES

From the point of view of traffic, a perfectly level street is most desirable. In some sections of the country it would be possible to have a large percentage of the streets perfectly level; in fact, in almost any locality it is possible to secure level locations for at least 50 per cent of the streets by following contours and making cuts and fills.

Where the roadway is paved in any way, however, or an unpaved road is on any but the most porous soil, it is necessary that the surface water be removed; and under prevailing plans of construction this requires that the gutter at least be given sufficient grade to carry off the surface water. It would be theoretically possible to have all streets perfectly level and make the curbs in the form of a vertical grating behind which and below the roadway level would be a channel for carrying off the water, which channel could be given any slope desired. Or the roadway could be dished, and a sloping channel placed in the center and covered by a grating. Neither of these expedients has proved successful in the few cases in which they have been tried.

MINIMUM GRADES.

Theoretically any slope at all to a gutter will provide for removing surface water, but the flatter this slope the slower the flow and consequently the deeper the water. Moreover, it is impracticable to make a gutter surface absolutely true to slope; and if it is very flat, minor depressions therein will cause the pooling of water. Consequently the rougher or more uneven the surface of the gutter, the steeper should be the minimum grade, as a general thing. The surface water will carry more or less suspended matter, some which will float but a con-

siderable amount will be dirt and grit which will require some velocity for removing it. Depth of water is desirable to prevent the floating matter from stranding, and it is not generally desirable that the dirt be washed into the sewer; consequently from this point of view the velocity should not be made too great. The minimum grade which has been established by the Corps des Ponts et Chausses for French streets is 0.8 per cent. The Troy Improvement Commission some years ago adopted 0.75 per cent. Flatter grades have been used for gutters in asphalt and wood block pavements. Seventh avenue, New York, has a grade of about 0.22 per cent continuing for 1½ miles above Central Park. Well laid brick gutters may have nearly as flat grades. We would suggest the following as the minimum grades which will give acceptable results: 0.25 per cent for asphalt or wood block; 0.25 to 0.50 per cent for brick or flag; 0.75 per cent for stone block; 1 per cent for cobble stones.

From the point of view of appearance, favorableness for traffic, and facility of construction, it is desirable to keep the form of crown of a roadway uniform throughout the length of a block, and this means giving the crown of the street the same slope as the gutter. The plan has been adopted in some cities, however, of making the roadway perfectly level at the crown and for about three-quarters of the distance toward the gutter, warping the remaining fourth of the surface next to the curb so as to provide for a gutter grade. Where this is done, the storm water inlets are usually placed at frequent intervals (say one at each corner and one in the center of each block), so as to reduce to a minimum the difference in level of the high and low points in the gutter.

MAXIMUM GRADES.

To confine the grades of gutters to a fixed maximum is very difficult if not impossible, and the elimination of the objectionable features of steep gutters is generally secured by some other methods, such as introducing dams or water-breaks in the gutter; giving the gutter a very uneven surface by using rough stone; laying the gutter in a series of alternate level stretches and drops,

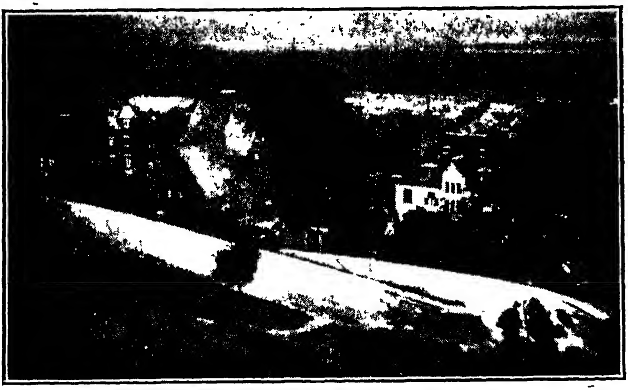
giving the effect of a flight of steps; and other expedients.

For traffic, the less the grade the less the energy or time required to travel a given distance. Therefore there is an actual saving of expense, in the form of either energy or time, in keeping street grades at a minimum. There is a certain amount of traction resistance due to axle friction and rolling resistance; the former depending to a considerable extent upon the construction of the wheels and bearings, the latter to the construction of the wheel, its width of tire and the nature of the roadway surface. Theoretically these two are constant, no matter what the grade; although tests seem to indicate that the grade has a slight affect upon the rolling resistance. Axle friction varies from about 1.2 per cent to 6 per cent of the load, the former for thimble-skein bearings with good lubricant, the latter for poorly constructed bearings without lubricant. For an ordinary well-constructed wagon, well lubricated, the friction may be taken as between 22 and 50 pounds per ton hauled. Numerous experiments have been made to determine by actual test the tractive resistance on level roads with various kinds of surfaces; that is, the total resistance from all causes except grade. These experiments indicate about the following: Asphalt, between 12 and 70 pounds per ton (this varies with temperature); brick, between 15 and 35; granite, between 25 and 80; best macadam, between 15 and 40; fair macadam, between 35 and 70; old macadam, 80 or more; ordinary dirt, about 200; loose sand, 300 or more. Grade resistance is equal to the grade percentage times the load. That is, on a 1 per cent grade the grade resistance is 20 pounds per ton; on a 2 per cent grade, 40 pounds, etc. This amount is to be added to the tractive resistance on a level to give the total tractive resistance, or the energy necessary to move the load.

There are other conditions affecting traffic resistance, such as the size of wheel and width of tire, the speed, etc. The width of tire would theoretically have no effect on a perfectly smooth and solid pavement, but on one which is compressible or irregular in surface it will have

more or less affect. Doubling the speed seems to increase traction resistance by about one-third on macadam, less on smoother pavements and more on rougher. It requires from two to six times as much tractive force to start a vehicle as to keep it in motion on a level at a speed of two or three miles an hour.

The part of the above consideration which is most important in this discussion is that referring to grade. Theoretically either horse or automobile should be able to climb any grade which is not too steep to permit the former to obtain a foothold or to furnish the latter sufficient friction between wheel and roadway. Practically, however, the grade may become so steep that a horse would not have sufficient energy to raise itself for a long, continuous stretch without drawing any load whatever. Moreover, the amount of load which either horse or automobile could draw would become so small for very steep grades that it might be uneconomical to endeavor to do any hauling over them. For instance, the grade resistance on a 20 per cent grade would be 400 pounds per ton, or say 425 pounds total tractive resistance on a fairly good, hard pavement. On a level, the resistance would be only 25 pounds and consequently require only



Courtesy, Barrett Co.

FIG. 127—"HAIRPIN TURN" ON HILLSIDE STREET.
Belvidere Road, Westmount, P. Q.

1-17 as much energy; or conversely, a given energy should be able to draw 17 times the load on the level that it does on a 20 per cent grade. Where there is any hauling to be done over a road, there is a money value which will last through all future time in reducing its grade; and ultimate economy would require a balancing of the cost of reducing grade (by cutting, filling or otherwise) against annual loss incurred by the additional tractive resistance of the steeper grade.

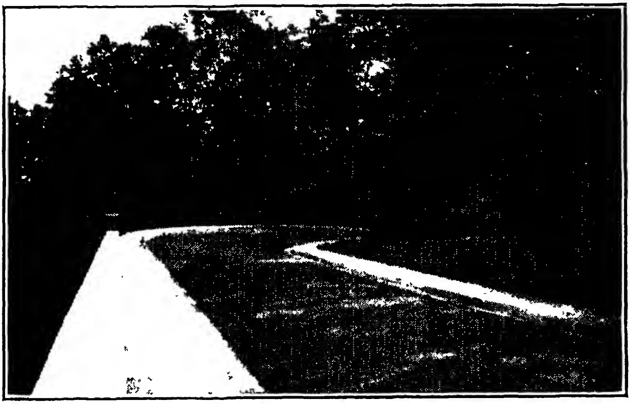
The problem also frequently offers another solution, that of reducing the grade by lengthening the route, either by winding or zigzagging up a hill, or in some cases by passing around the hill through a valley or other depression. A certain amount of lengthening of road, because it permits heavier loads to be hauled or better time to be made, or both, may cause the longer road to be more favorable than the shorter and steeper one. This was discussed in the last chapter entitled "Motor Trucks and Street Grades." Calculations given therein indicated that, for automobile trucks, there would be little advantage in making a detour to avoid a 3 per cent grade; an increase of length of road by as much as 75 per cent would be warranted where the grade was 6 per cent; while if the grade amounted to 8 or 10 per cent, a route 3½ times as long would not consume any more time or energy. The roadway in each case was assumed to be paved with granite blocks offering a tractive resistance of 40 pounds per ton.

Where the roadway is less favorable to traffic, such as a macadam offering a tractive resistance of 60 to 100 pounds per ton, the advantage of the longer road would be less, or rather the length of detour which would be equally advantageous would be less. In planning streets, however, it should be assumed that ultimately, if not at present, the best kind of roadway surface will be constructed, and therefore, the problem of location should be solved on the hypothesis of minimum resistance due to such surface.

It is apparent that it is largely a matter of judgment or of local conditions what shall be taken as a maximum grade. Where a city is located in a hilly country where

almost all streets and roads have more or less grade and loads are customarily made lighter because of this, it would be justifiable to use steeper grades as a maximum than on the infrequent hills in a city where most of the streets were practically level. F. C. Thompson, Engineer of Highways of Bronx Boro, N. Y., has stated that he considers 3 per cent the steepest grade desirable for sheet asphalt and creosoted wood block; 6 per cent for asphalt block; 4 or 5 per cent for vitrified brick and 13 per cent for soft granite or Medina sand stone. Asphalt has been laid, however, on a 17 per cent grade in Pittsburgh, but is by no means recommended for such steep grades. Among steep street grades to be found in this country are the following: In San Francisco. 25½, 21½ and 18 per cent on Sacramento street; in Rochester, N. Y., 17.8 per cent; in Cincinnati, O., 16 per cent. New York city some years ago adopted 18 per cent as a maximum grade for its thoroughfares, and the Troy Improvement Commission adopted 7 per cent.

While these steep grades may be permissible for local streets or minor residence thoroughfares, where most



Courtesy of Barrett Co.

FIG 128—TERRACE CONSTRUCTION ON A HILLSIDE STREET.

of the traffic consists of carriages and light delivery wagons with only an occasional coal wagon or moving van, in or near transportation centers grades should not exceed 2 or 3 per cent, nor should they exceed 5 or 6 per cent in a business district, where it is possible to keep them down to these maximums by any care in planning or practicable cost of grading. In many cases excessive grading may be postponed until the traffic warrants or the money can be raised; but the final grade should be considered in laying out the plan, and the latter modified if necessary to keep the cost of the future grading at a minimum.

CHAPTER XXII.

PLANNING GRADES

In deciding upon exact location of a street on the plan, grade and cross section should be considered and the location of the street varied to secure the best conditions in each of these with a minimum expenditure for grading. This may mean the shifting of the street line up or down hill and the introduction of curves or a winding route for the street, in order to avoid excessive cutting or filling.

Not only should the grade of the single street in question be considered, but also that of the cross streets. Occasionally a cross street is carried under or over a hillside street by a bridge, but ordinarily the two cross or intersect each other at grade. Consequently the grades of the cross streets must to a considerable extent be planned at the same time as those of the hillside street, and each adjusted to the other so as to produce the best practicable results in the street system as a whole, combined with a minimum economy of construction. In such design, however, the relative importance of the two streets as thorofares should be considered, that which will carry the most and heaviest traffic being given the preference over local and minor streets in this inter-adjustment of grade and location.

One of the most difficult elements of designing hillside streets is the securing of the best or even fairly satisfactory conditions as to relative elevations of the four curb intersections and the four property line corners, together with the sidewalk slopes at these points. This problem will be discussed in a future issue.

Grades should be continouus, or change infrequently. Undulating grades are objectionable to traffic and also

in appearance. On a main thorofare the grade should be made practically continuous at almost any expense of grading or modification of intersecting streets. Theoretically a hill should be mounted by a continuous grade, since any flattening of the grade at one point must be compensated for by steepening the grade at another. It will be desirable, however, to flatten the grade at intersecting streets if it exceeds 3%. If the street is a thorofare and the grade is not uniform throughout, the steepest part should not have more than double the average grade of the street if this is possible, nor should any such steep grade exceed 1000 or 1500 feet in length; since if the steep stretches are thus limited, they will not seriously reduce the weight of load which can be drawn up the hill.

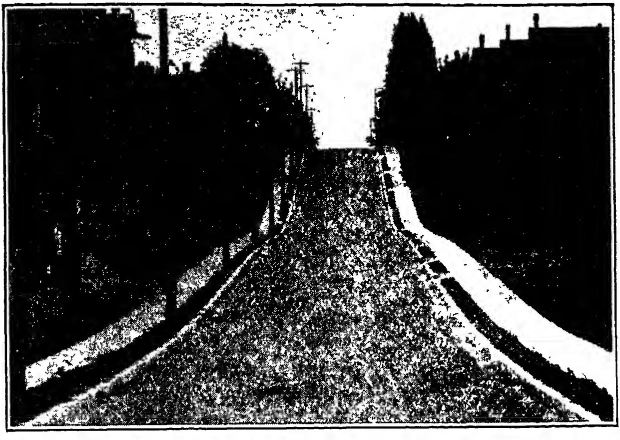
A change in a street grade should never be made as an angle, but dissimilar grades should always be connected by a vertical curve. The longer the radius of this

Courtesy Paterson Mfg Co.

FIG 129—GOOD VERTICAL CURVE

17% grade in background Argyle Avenue, Westmount.

curve the better the appearance and the easier the riding. We would suggest, as a minimum length of such a curve, 20 times the difference between the steepest and the flattest grades, both grades being expressed in per cent, and one being minus if they slope in opposite directions. Vertical curves must sometimes be shorter than this rule would require, as where the grade is flattened at street intersections; but 150 to 300 feet seems to be the minimum length which does not appear to be objectionally abrupt. In crossing a main thorofare, the angle between the main grade and the crossing grade of the minor street may be fixed at the property line and the forward end of the curve at the curb line, thus giving the curve a length equal to twice the width of the sidewalk. Under certain conditions where neither street is a main thorofare, or for a main thorofare crossing a minor street, the grade angle may come at the curb line and the curve extend to the center of the roadway. In



Courtesy Barrett Co.

FIG 130—UNNECESSARY UNDULATION IN GRADE AT MIDDLE OF BLOCK

general, vertical curves should be of uniform radius throughout and therefore extend the same distance each way from the grade angle.

As in the case of roadway crowns, the simplest curve to lay out is a parabola, the ordinates of the curve from the grade lines varying as the square of their distances from the end of the curve. The middle of the curve will come half way between the intersection of grade lines and a chord connecting the two ends of the curve.

Vertical curves require a little more field work than straight grades for the laying out of the grades for curb, sidewalk and roadway pavement, but this is a matter of extremely minor consideration as compared with the improvement in appearance of the street. Moreover, the wear of the roadway from traffic and of this and the gutter by scour of street water is reduced by curves. This is indicated by the fact that nature always rounds off grade variations in this way; or if a stream bed should contain an angle in grade, excessive errosion will occur at this point.

In planning street grades it will of course be kept in mind that there should be no "pockets" or low points in any gutter which have no outlet to either a natural stream or a sewer which is already in existence or will be built before the street is completed.

Where steam railroads exist or it is possible to anticipate their future location, the grades should be so designed as to avoid grade crossings, even if considerable expense is involved. Many a city has found its vital interests seriously menaced by the interference with roadway traffic caused by grade crossings which are closed to street traffic at frequent intervals to permit the passing of trains or switching of freight cars. If possible, the track should be depressed and the streets raised, for a railroad fill through a town is a calamity, while a cut is not nearly so objectionable, and serves to conceal to a large extent the undesirable features connected with a railroad right of way. If the street passes over a railroad, a clearance of 18 to 20 feet is generally required. If the street passes under a railroad a clear-

ance of 15 to 18 feet is customary. In a few cases where the street is carried under the tracks, the sidewalks are not depressed so much as the roadway, since a clearance at the sidewalk of 8 or 10 feet is sufficient, or 7 or 8 feet less than is necessary for the roadway. This not only permits a more nearly level sidewalk grade, but also one which is not depressed so much below the abutting property and is less objectionable on this account.

Where a local street connecting two parallel streets would have an undesirably steep grade, an expedient is to run said local street at an approximately level grade from each of the parallel streets to a point about half way between them; at which point these two sections of the street would then be at considerably different elevations. At this point a retaining wall is placed across the street. Each half of the connecting street thus becomes

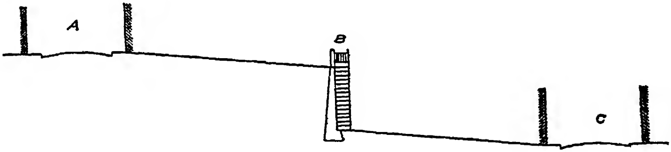


FIG 131 —CROSS STREET WITH BROKEN GRADE.

a dead end for vehicle traffic, and the roadway must be sufficiently wide to permit vehicles to turn. Steps are frequently placed along the face of the wall or parallel to the street line to permit foot traffic to pass from one level to the other and thus continuously through the block.

CHAPTER XXIII.

GRADE AT INTERSECTION

A sidewalk should slope away from the building line in order to throw the rain water away from rather than toward buildings or private lands. The extreme condition permissible would be a sidewalk level from property line to curb for a few feet only. As stated in Chapter XVIII, a slope of one inch in two feet (about 4%) is about the steepest which is desirable, while 2% is a good standard cross-slope.

If we assume a curb intersection (*c* in Fig. 132), with an elevation of 100.00, a 4% grade down one of the inter-

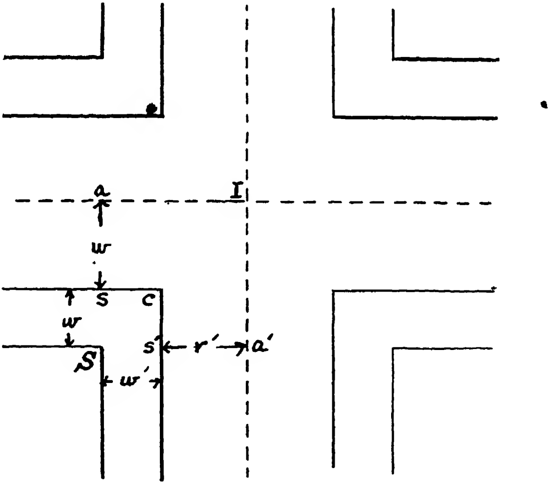


FIG 132—CALCULATING MAXIMUM FALL FROM s to s^1.

secting streets and a 6% grade up the other, and both sidewalks 12 feet wide, we have the following conditions: The curb on the descending grade at a point *s*, opposite the intersection of the property lines, would have an elevation of (100.00 — .48 =) 99.52. The curb on the ascending grade at a point s_1 would have an elevation of (100.00 + .72 =) 100.72. If we give the sidewalks a slope of 2% from *s* to *S*, we have the elevation of *S* as 99.76. If we slope the sidewalk from s^1 to *S* at 2%, we have the elevation of *S* as 100.96. This gives us two elevations 1.20 feet apart for the same point.

Again, if we assume that the roadway crown falls at a 4% grade from *I* to *a*, and rises at a 6% grade from *I* to a^1, each street being 60 feet wide, we have a_1 3.00 feet higher than *a*. If the curb at *s* and s^1 has the same elevations as the roadway crowns opposite, then one is 3.00 feet higher than the other, and the point *S* has two elevations differing by 3.00 feet. Also, if each curb has the same grade as the roadway, the point *c* has two elevations differing by 1.8 feet.

It is of course impracticable to construct the sidewalks as indicated, which would require a retaining wall extending from *c* to *S*, 1.8 feet high at one end and 3.00 high at the other. Or steps might take the place of the retaining wall. A construction approximating this is shown in the photograph, Fig. 133.

The problem presented by this example is typical, and

FIG. 133.—TURNING A DIFFICULT SIDEWALK CORNER. An example from Covington, Ky.

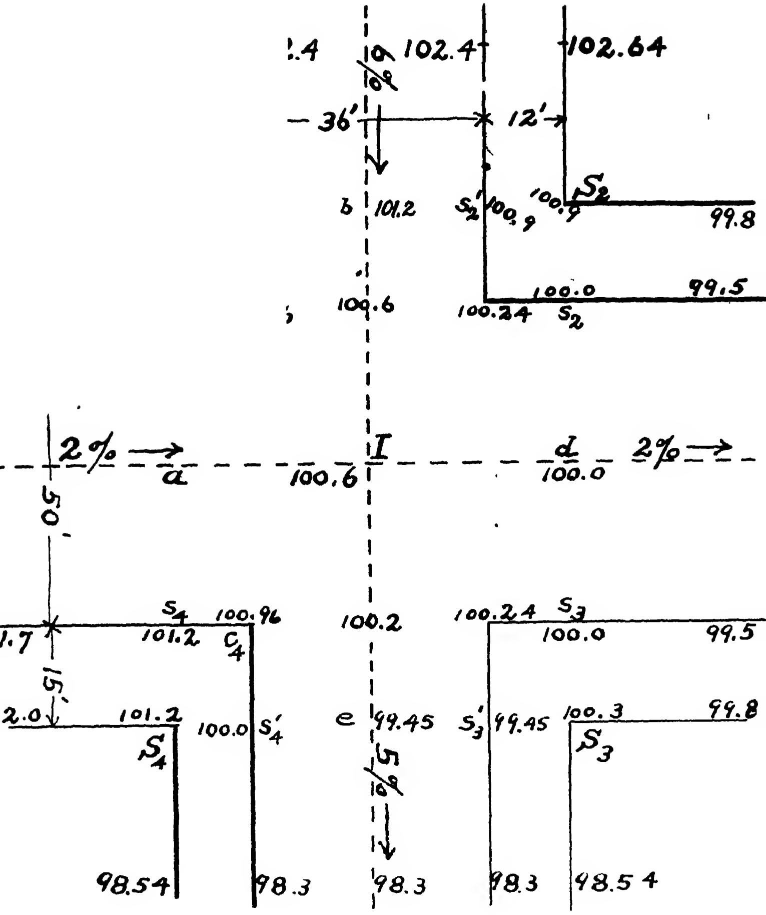


FIG. 134.—CALCULATING STREET INTERSECTION GRADES

the solution of sidewalk grades at such corners is one of the most vexing problems confronting the city engineer, for the reason that there is no really satisfactory solution when the conditions are at all extreme. Where both sidewalks are falling toward or both from an intersection, there is little difficulty—none at all if the grades are the same. But where one of two intersecting curbs rises and the other falls, and both at considerable grades, then some compromises are necessary.

Taking first the point *c*. If the rule is to keep the curb at, or a uniform distance above or below, the elevation of the roadway crown; and if the crowns *Ia* and *Ia*¹ fall and rise respectively from *I*, then *c* will have two elevations, one corresponding to the crown of each roadway. This is not permisible. Therefore either the roadway crowns must both have the same elevation at the points opposite *c*; or else *c* must be higher than one crown, or lower than the other, or both.

Having settled this point, we have exactly the same problem with respect to *S*. Unless both curbs are run level (or sloping in the same direction and at the same grade) from *c* to *s* and *s′*, then the slopes of the sidewalks from *S* to *s* and *s′* respectively must be different. The latter is practicable within limits. As an extreme, *Ss*¹ might be level, and *Ss* have a slope of say 5%; which would place *s* 0.6 foot lower than *s*¹ as the limit of difference of elevation between these points.

If *cs* and *cs*¹ are carried level, and the rule that curb grade must be parallel of roadway crown to be adhered to, then *Ia* and *Ia*₁ must be made level also. The easiest solution, as far as office work is concerned, is to make all four corners S_1 S_2 S_3 S_4 (see Fig. 134) at the same elevation, in which case all the points *s* would have the same elevation, all points *c* the same, and the elevations of *a*, *b*, *c*, *d*, and *e* would be the same. Where the ground is comparatively level this is generally the best solution. (In this discussion, changes in grade are treated as angles, but they should be replaced by vertical curves in the actual layout, which curves might have the vertex at *s*, the P. T. at *c*, and the P. C. back from *s* a distance equal to the sidewalk width. Curbs also are considered

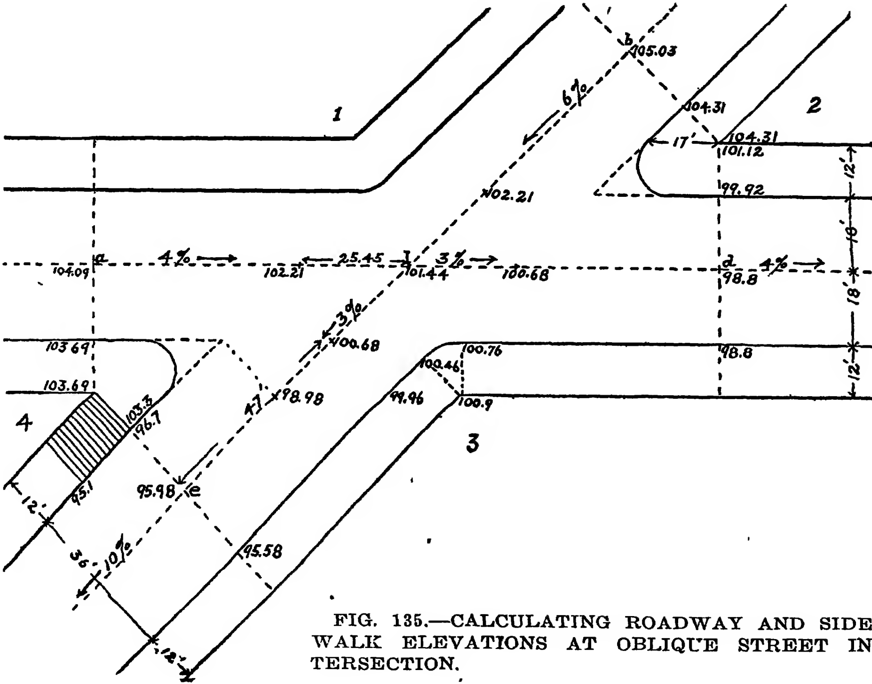


FIG. 135.—CALCULATING ROADWAY AND SIDEWALK ELEVATIONS AT OBLIQUE STREET INTERSECTION.

to meet at an angle, but will generally be rounded at the corner with a radius of between 2 and 20 feet).

But if one of the intersecting streets is a thorofare, it is generally desirable to continue it across the intersecting street with grade unbroken, or flattened as little as possible—certainly not made level. Even if neither street is a thorofare, it is not often desirable to carry each or either level across the intersection. So the plan of making the "platform"* level is not applicable to all cases, or to many in a hilly country.

It is therefore necessary to make variations from the general standard at corners where the streets are not level. Such variations are as follows: One sidewalk may be made level, the other given excessive slope up to a maximum of 6%; or possibly 8%, or even 10% under the most extreme conditions. The curb faces may vary in height from 4 inches to 10 inches; may be made 12 to 16 inches high if double or stepped; or may even be continued higher as a retaining wall.† The roadway may be made "lop-sided," as explained in Chapter XVII, the limit being a continuous slope from one curb to the other of 4%; making one gutter 1.44 feet lower than the other, for example, on a 36-foot roadway.

A number of plans have been suggested for working out this problem of street corner grades. One was described in Municipal Journal for October 20, 1909. A suggested modification, based upon ideas and suggestions of a number of experienced engineers, is explained in Chapter XXIV.

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*The area between the lines connecting the points S_1, S_2, S_3 and S_4, Fig 134, is called the building line platform. That between lines connecting the curb corners is called the curb line platform. When the streets do not intersect at 90°, the lines bounding the platforms are the street lines or curb lines, respectively, and perpendicular to them from the acute intersections, as shown in Fig. 135

†In the case of minor streets, the sidewalk may be placed at almost any height above the roadway, as previously explained

CHAPTER XXIV.

INTERSECTION GRADES

While all degrees of variation of surface will be found at street intersections, from level ground to 15% grades, or even steeper, on both streets; and in addition existing street pavements, buildings, and other structures may exert considerable influence in the establishing of grades; yet there should be certain principles established as a guide, and certain limits which only the most urgent necessity should be accepted as reason for exceeding. Cer- rinciples may be stated as follows:

grade of a thorofare should be given preference - .. hat of a minor street, and be continued unbroken (at least so far as the street center is concerned) across an intersection; except that if the grade exceeds 4% or 5% it should generally be flattened to such percent at a crossing of any importance. If two thorofares intersect or meet, the grade of each should be flattened to about 3% between curb lines if the general grade exceeds that; otherwise the grade of each may be continued unbroken.

A secondary or local street which crosses a thorofare should be level from the center of the thorofare roadway to the curb line on the up-hill side; and on the descending side should follow the natural crown of the thorofare to the down-hill curb. The regular grade of the cross-street would begin at each curb line, unless flattened to the building line for reasons to be described.

The curb line grade should be parallel to that of the center line of the street, except at the intersections. Therefore the above, which apply to roadway crowns, may be used for fixing the curb grades also; but the latter may need to be modified within the building line platform to meet the difficulties already described.

The limits of curb height may be taken as between 4 inches as a minimum, and any height as a maximum if stepped curbs or retaining walls are used.

The sidewalk cross-slope may be level for a length of not to exceed 25 feet. Its maximum should be kept at 6% if possible, with 8% or 10% allowable as an alternative to steps or other construction more objectionable even than such steep cross-slope.

The maximum difference in elevations of opposite gutters should be that which would be produced by a continuous cross-slope of roadway of 3% or perhaps 4%—more than 5% is seriously objectionable.

Changes in curb or crown grade are to be made in the construction by vertical curves. The property line grade should be made straight unless this would bring *S* lower than *s* or too high above it, in which case it also should be given sufficient vertical curve to avoid this.

The sidewalk, if it does not have the standard cross-slope at *Ss*, should be warped uniformly so as to attain this slope (generally between 2% and 3%) at a point 25 feet back of *S*.

First trying the calculation using standard grades, slopes and curb heights, the elevation of *S* at each of the four corners is obtained by adding to the higher *s* the slope of the sidewalk at 2%; the slope *s′ S* coming as it may. If *s′ S* then exceeds 6%, *s S* is flattened sufficiently to reduce it to 6%, if to do so does not require it to be sloped toward the building line; if it should so require, *s S* is made level and *s′ S* comes as it may. But if *s′ S* would still exceed 8 per cent or 10 per cent, the street line grade must be changed, or the curb grade of one street lowered or that of the other street raised, or both.

If starting the regular grade of an intersecting street at the curb line would make it impossible to keep the sidewalk slopes within the limits given (6 per cent and 8 per cent or 10 per cent grade), then the grade of said street must be flattened from curb line to property line sufficiently to permit this, and the regular grade begun at the property line.

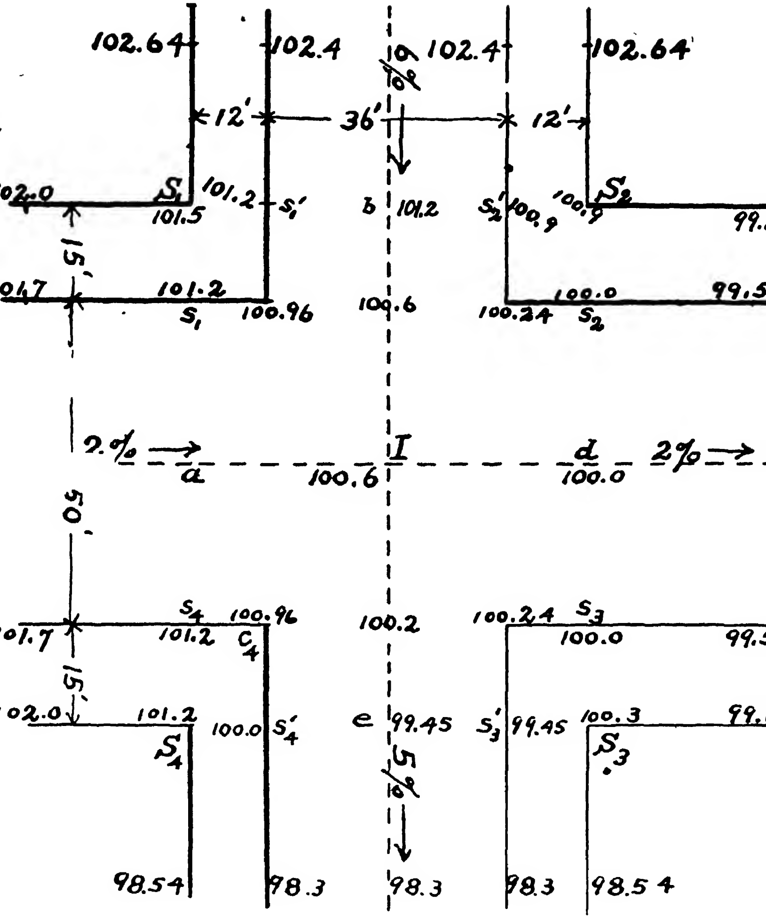

FIG. 136.—CALCULATING STREET INTERSECTION GRADES

An application of these principles to special cases is given to illustrate the procedure. The first case is that of two streets intersecting at right angles, one an 80-foot thorofare on a 2 per cent grade, the other a 60-foot secondary street having a 6 per cent approaching and 5 per cent departing grade, shown in Fig. 136.

The center line grade of the thorofare is carried uniform, that of the cross street is reduced to a level from the upper curb line to *I*, and dropped by the amount of crowning (0.4 foot) at the lower curb line. The curbs on the thorofare are both given the same elevation as the center line throughout.

The difficult corners at any intersection are those whose including lines slope, one up from the corner, the other down. (Also, in oblique intersections, the acute angles. When these two coincide, as in Fig. 137. we have the maximum difficulty.) Considering S_2, we give this elevation 100.00 plus (6 per cent of 15) = 100.90. *b* would be 100.6 plus (6 per cent of 15) = 101.5; but s'_2 cannot be as high as this, since S_2 is only 100.90. We accordingly make $s'_2 = 100.9$. s'_1 may be made the same as s_1 (101.2), as is always desirable when possible; and *b* may be 101.2, or (averaging s'_1 and s'_2) 101.05 instead of 101.50.

Twenty-five feet to the right of s_2 the curb would be 99.5, and adding a 2% sidewalk cross-slope, the property line opposite here would be 99.8. Similarly, 25 feet above $S_2 s'_2$ the curbs would be 102.4 and the property lines 102.64.

Considering S_4, this we will make 101.2 (the lowest possible), since the curb falls rapidly from c_4 down the cross street. The lowest s'_4 should be made is 101.2 — (10 per cent of 12) = 100.00. *c* would be 100.2 minus (5 per cent of 15) = 99.45. Allowing a 0.4-foot curb at s'_4, this makes *c* 0.15 lower than the gutter at s'_4. s'_4 cannot be lowered (without changing the thorofare grades), consequently either the curb at s'_4 must be made higher (say the gutter is made 99.15, when the curb height would be 100.0—99.15, or .85 foot high); or *c* must be raised, or the crown of the cross street thrown

to the left of the center. Assuming that e remains at 99.45, the gutter at s'_8 may be made 99.05, and the curb here be made 99.55. Calculating from the thorofare curb, S_8 should be 100.30; and as this gives a fall from S_8 to s'_8 of about 6 per cent, this elevation for S_8 may be used.

If the 5 per cent grade had been continued from the point 25 feet below e across the thorofare to the point 25 feet above b, it would have had an elevation at the latter point of 104.8 instead of 102.4. If continued beyond this point, it will intersect the 6 per cent grade at a point 240 feet further. That is, if the general slope of the ground is 5 per cent, and the blocks are about 300 feet wide between thorofares, the street slope must be changed to 6 per cent to allow for flattening at the thorofare crossings.

CHAPTER XXV.

INTERSECTION GRADES

(Continued)

The drawing Fig. 137 illustrates an extreme case, in which an acute angle is combined with a rising grade up one street and a falling grade down the other. As this is recognized as, an extreme case, limiting deviations from the standard are used at the outset. Corners 2 and 4 are the most difficult ones, the latter especially so because of the steep grade—10 per cent.

To begin with, the elevation of I is taken as 101.44 and each street center line is reduced to 3 per cent grade between intersecting curb lines. Each roadway is given a continuous cross slope of 4 per cent from upper to lower curb. This gives $s_4 = 103.69$, and S_4 is made the same.* $c = 100.68 - (10$ per cent of $47) = 95.98$; the gutter at s'_4 becomes 96.70; curb 97.10, and 10 per cent sidewalk slope gives $S_4 = 98.30$, or 5.39 ft. lower than its elevation as calculated from s_4. Apparently some radical solution is necessary. We may introduce steps in the sidewalk leading down from the line $S_4 s_4$, giving s'_4 elevation 103.3 at the top of the steps (as in the illustration). Or the curb at s'_4 may be made 103.3, with a face 6.6 ft. high above the gutter—a retaining wall—and a sloping sidewalk be substituted for the steps, falling gradually to street level by using a grade of say 15 per cent. Or the street bc may be carried level from I to c making $c = 101.44$, making the curb 10 in. high, making $s'_4 = 102.99$, and giving the sidewalk $S_4 s'_4$ a 6 per cent slope. This, however, involves raising the roadway 5.46 feet at c and the lower sidewalk opposite it by the same amount, and thus not only requires considerable filling but increases the already steep grade down from c. Another possibility is flattening the grade from c

*For meaning of letters see previous chapters.

to the left of the center. Assuming that e remains at 99.45, the gutter at s'_8 may be made 99.05, and the curb here be made 99.55. Calculating from the thorofare curb, S_8 should be 100.30; and as this gives a fall from S_8 to s'_8 of about 6 per cent, this elevation for S_8 may be used.

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CHAPTER XXV.

INTERSECTION GRADES

(Continued)

The drawing Fig. 137 illustrates an extreme case, in which an acute angle is combined with a rising grade up one street and a falling grade down the other. As this is recognized as, an extreme case, limiting deviations from the standard are used at the outset. Corners 2 and 4 are the most difficult ones, the latter especially so because of the steep grade—10 per cent.

To begin with, the elevation of I is taken as 101.44 and each street center line is reduced to 3 per cent grade between intersecting curb lines. Each roadway is given a continuous cross slope of 4 per cent from upper to lower curb. This gives $s_4 = 103.69$, and S_4 is made the same.* $c = 100.68 - (10 \text{ per cent of } 47) = 95.98$; the gutter at s'_4 becomes 96.70; curb 97.10, and 10 per cent sidewalk slope gives $S_4 = 98.30$, or 5.39 ft. lower than its elevation as calculated from s_4. Apparently some radical solution is necessary. We may introduce steps in the sidewalk leading down from the line $S_4 s_4$, giving s'_4 elevation 103.3 at the top of the steps (as in the illustration). Or the curb at s'_4 may be made 103.3, with a face 6.6 ft. high above the gutter—a retaining wall—and a sloping sidewalk be substituted for the steps, falling gradually to street level by using a grade of say 15 per cent. Or the street $b c$ may be carried level from I to c making $c = 101.44$, making the curb 10 in. high, making $s'_4 = 102.90$, and giving the sidewalk $S s'_4$ a 6 per cent slope. This, however, involves raising the roadway 5.46 feet at c and the lower sidewalk opposite it by the same amount, and thus not only requires considerable filling but increases the already steep grade down from c. Another possibility is flattening the grade from c

*For meanings of letters see previous chapters.

toward *I*, and increasing the 3 per cent grade across the intersecting roadway to 4 per cent; also reducing the grade from *d* to *a* to 2 per cent, which of course requires somewhat increasing the 4 per cent grade to the left from *a*, and increasing the grade above *b*. Which of these expedients (or what combination of them) is best for this case would have to be decided by local conditions, such as relative importance of roadway and sidewalk traffic; effect the plan would have upon availability and cost of grading of the several corner lots, etc.

At corner No. 2 the problem can be solved by using the limiting grades and slopes without recourse to unusual construction. Making the gutter opposite *b* 104.31, and the curb 4 inches higher and the sidewalk level, gives S_2 104.64; while the maximum rise from *d* would be .72 for roadway, .83 for curb and 1.20 for sidewalk, or 2.75; giving S_2 101.55, or 3.09 lower than the other elevation for the same point. But if we carry the 3 per cent grade from *I* to *b*, this makes the latter 103.62, a reduction of 1.41 feet. If the 3 per cent grade be continued from *I* to *d*, this makes *d* .47 foot higher, bringing the total gain to 1.88 feet. The remaining 1.21 feet could be added to the curb height, making this 2.04, the curb being built as three or four steps at this point.

For an extreme condition like the above, none of the solutions suggested is more than a makeshift. If the grades are being adjusted throughout or can be changed without too great expense, a more satisfactory solution is to reduce the center line grades between *a* and *d*, and between *b* and *c*, to 2 per cent. Then $e = 99.99$ and $a = 102.89$; $s_4 = 102.49$ and $S_4 = 102.49$. From *e*, $s'_4 = 101.11$ and $S = 102.32$. The difference in these values of *S* (0.17) can easily be adjusted by making the curb at s'_4 0.57 ft. high instead of 0.4 high. Had the crossing been a right angle one, a 3 per cent grade for the building line platform would have served.

As stated, some of the elevations given above are to be modified by connecting the grades with vertical curves. A simple calculation, based on the principles of the parabola, shows that the curve at the intersection

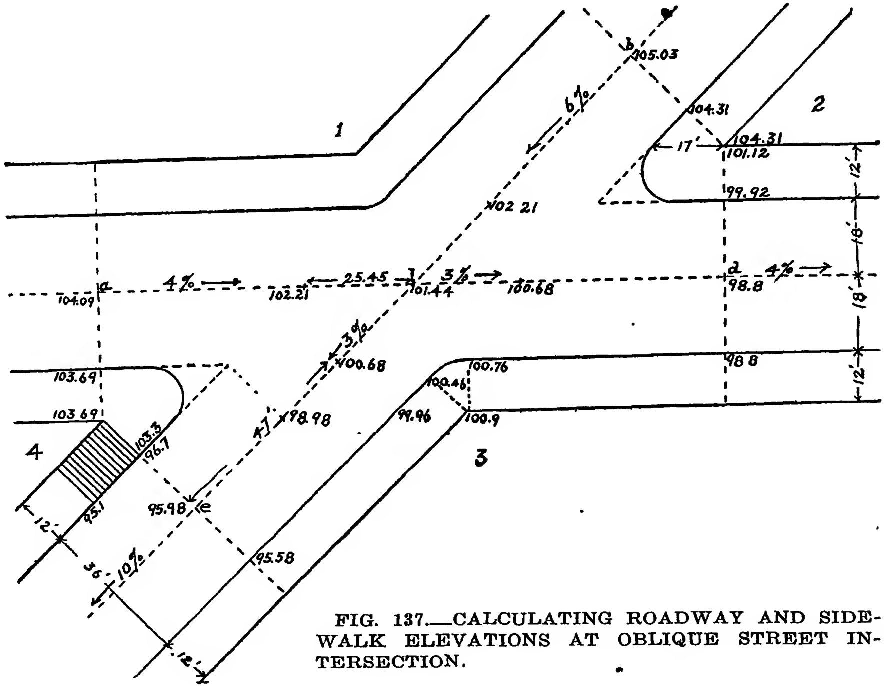


FIG. 137.—CALCULATING ROADWAY AND SIDEWALK ELEVATIONS AT OBLIQUE STREET INTERSECTION.

of the grade lines would be higher or lower than such intersection by an amount equal to .25 l $(g - g')$, in which l is the distance from vertex (intersection of grade lines) to P. C. or P. T., and g and g' are the two grades expressed as per cent. For example, if a 3 per cent and 6 per cent grade meet at a property line, and l is taken as the width of the sidewalk, say 12 feet, then the curve at the vertex is raised or lowered from the vertex .09 foot. If l is taken as 100 feet (which is preferable if conditions permit), the vertex elevation is changed .75 foot. If one of the grades is rising and the other falling, one g is called minus and the grade percentages are really added. For example, if a rising 3 per cent grade changes to a falling 6 per cent, the elevation of the connecting curve above or below the vertex would be 2.25 feet, if l is taken as 100 feet.

In all of these calculations it is assumed that the streets are being designed for business purposes or thorofares, with the sidewalks paved out to the curbs and the curb heights kept at a minimum. If, however, they are in a section which will always or for many years be purely residential, then the sidewalks can be raised almost any distance above the roadways, and connected with them by terraces or retaining walls, as described heretofore. In such cases the roadway should be crowned symmetrically with reference to the center line, the two gutters being given the same elevation. The lower curb would probably be made a minimum (say 4 inches) to reduce cost of grading. The roadway could be kept at the minimum width which will accommodate traffic and placed nearer the down hill than the up hill property line, thus reducing grading and giving a wider space for terracing along the upper sidewalk. The roadways at intersections would follow the principles stated. The more important one would run across without any break except that the up-hill side would run level from the crown along the crown of the less important intersecting street and that its grade, if it exceeded 3 per cent, would drop to 3 per cent across the intersection. If the roadways are equally unimportant as traffic car-

riers, each would drop to a grade not exceeding 3 per cent at the crossing—both might run level between curb lines. The sidewalk pavements would all be given the most desirable cross-slope—say 2 per cent, and steps or inclines provided at the corners if necessary, as previously described.

But if there is any chance that the streets will at any future time become business streets or thorofares for foot traffic, then the calculation of grades and elevations should be made after some such manner as that described in these last three installments, and such grades and elevations adopted as official. The roadways should be graded and paved in accordance with these official grades; but the sidewalks can be graded and built temporarily to fit the ground more readily, as just described; it being understood that, whenever it may become necessary, the city can order the owners to rebuild them in accordance with the official grades and elevations.

CHAPTER XXVI.

GUTTERS

A gutter is provided to carry water which fl
the roadway and sidewalk and conduct it to a s
or other point where it is removed from the s
face. It should be so constructed and maintai
receive the water, carry it at a fair speed an
minimum of erosion thereby. It should offer n
tion to traffic or as little as possible.

Gutters can be found by the score which do n
all of the water from the roadway, or even any
light storms, either because the roadway has w
lower than the gutter, or because a rut or shal
has worn and washed along the outer edge
The crown of dirt, gravel and macadam roads
more or less rapidly by use, and the fine mat
from washes into and frequently settles in th
Allowance should be made for this by provi
cient crown at first, and making the cross sl
gutter steeper than at the haunches of the r

Where a gutter of concrete, or of brick or
concrete base, is built in combination with a dir
bound macadam roadway, the wear and wash
sure to start a rut alongside the outer edge of t
and once started, wheels will follow in it and s
ter flow down it with the result that it will deep
And when this occurs, little water will reach
proper, but its place will be taken by the rut.

For rapidly wearing or easily eroded road
it is better, therefore, to build the gutter sev
lower than the roadway, and so maintain the lat
ridge or rut forms between the two to interce
ter; or else to build the gutter of a mate
will either wear as rapidly as the road, or wi

that the edge of the gutter lowers as the roadway wears down. A combination of both is probably best.

To secure the latter result, cobble stones well bedded, laid close together and with a uniform surface are perhaps most satisfactory; although much the same results can be obtained by use of small irregular-shaped stones—"quarry spalls." If the roadway surface lowers by wear or otherwise along the edge of the gutter, the occasional team which draws in to the curb will press down the stones of the gutter to the same level; or will at least press down an occasional one, which will permit the surface water to pass from roadway to gutter at frequent intervals. A concrete gutter, however, will not settle, but will be ground or broken off more or less continuouslv along the edge, but will not settle so as to permit the water to flow onto it. (This is assuming that there is not a rapid drop in the roadway surface just outside the gutter.) For many conditions perhaps the most satisfactory result is obtained by using a concrete gutter with a strip of small cobblestones between it and the roadway, such strip having a drop of two or three inches from roadway to concrete gutter, and settling under traffic as the roadway wears down.

A well laid cobble gutter costs as much as or more than a concrete and gives a less finished appearance; but we believe the former gives better satisfaction for use with any pavement less durable than a good grade of bituminous concrete or bituminous macadam. One objection to the cobble is the fact that grass frequently grows between the stones. This may be prevented by use of salt or one of the weed killers, or by covering the cobble gutter with a tar or asphalt paving compound, which will also give a smooth gutter. The latter plan is especially applicable if the road is top-dressed with a bitumen.

The appearance of a gutter well laid with small stones is, to our mind, more in keeping with a residence street lined with trees and paved with macadam or not paved, than any of the other gutters.

Where the roadway is paved with a hard and durable pavement such as stone block, brick, concrete, asphalt, wood blocks, etc., the material used for the roadway is also suitable for the gutter, and there would seem to be no reason why it should not be used for it, the gutter being in fact but a name to designate the foot or two of pavement nearest the curb over which the surface water flows. (Sheet asphalt pavements are now laid which suffer little if any disintegration from water standing on them; although a few years ago it was thought desirable by several cities to place concrete or brick gutters on streets paved with asphalt to prevent such disintegration.) For such pavements, therefore, there are no gutters built of a separate material. Some cities, however, lay brick or stone blocks lengthwise of the roadway for a foot or two from the curb, when the balance of the roadway is paved with the same material laid crosswise of the roadway.

There are some special locations where a stone block or tough brick surface is desirable, laid as a wide gutter in connection with sheet asphalt or softer paving materials; these being especially where horses are accustomed to stand for long periods and paw or stamp, as at street market stands. But this is not strictly a gutter, but a special construction which occupies the gutter location

There are differences of practice as to width of gutter, but the most common width appears to be 18 inches, few

being narrower than 15 inches or wider than 30 inches. It would seem that the gutter should be of such width and slope that it will carry all the water that will reach it, without overflowing onto the roadway beyond the gutter. To accomplish this it is often desirable, where much water is carried by a gutter, to give the gutter a considerable pitch toward the curb, or dish it into the form of a channel. Some cities, in building brick gutters, have laid along the outer edge a row of brick on edge and extending about an inch above the gutter level, the roadway

Courtesy, Paterson Mfg. Co.

FIG. 139. DEEP COBBLE GUTTER ALONG BITUMINOUS ROAD

At Pointe Claire, Canada. At tree sidewalk might have been curved out over a pipe culvert similar to those shown.

surface being brought flush with the top of this elevated strip.

The gutter can, of course, be quite deep, taking the form of a ditch; but while this may be all right for a country road (although even here there is danger of a vehicle upsetting into the ditch on a dark night, or with a careless driver, or in passing a wide load of hay), it is undesirable for a city roadway in that it narrows it by the amount of its width, prevents a vehicle drawing up to the sidewalk, and even presents a barrier between roadway and sidewalk which can be crossed only at occasional bridges. There would seem to be no good reason, however, why the gutter can not be dished six inches or so, where there are considerable volumes of water to be carried, to prevent the run-off from rains flowing along and washing out the dirt or macadam roadway next to the

CHAPTER XXVII.

SIDEWALKS AND SIDEWALK CONSTRUCTION

The location of the sidewalk in the street and the width which is desirable both for the sidewalk area and for the paved portion have been discussed in previous chapters of "Practical Street Construction." In considering the subject of sidewalks more particularly it may be worth while first to review briefly a few of the general principles therein stated.

The object of a sidewalk is to afford a dry, convenient and safe way for pedestrians, where they will be protected from vehicles, horses, dirt and street drainage and in some cases even from sun and rain. To be [illegible] pavement must rapidly shed all the water which comes upon it in the form of rain or water used in washing it or (in some cities) that which runs onto it down alleyways from the rear yards of the abutting houses. It must also be elevated above the roadway by such amount that the rain water or flushing water flowing in the gutters at any time, except after most unusual downpours, will not rise onto the sidewalk pavement. In addition to this, the pavement should be of even surface so that the water will not stand upon it in puddles; and should absorb very little water, or else should be porous and thoroughly under-drained in order that the water may escape rapidly through it.

In order to be convenient, the sidewalk should be as flat transversely as is possible and still secure drainage, and should have as little grade longitudinally as the topography will permit; and the surface should be uniformly even, smooth but not slippery, and with no sudden

made abruptly. The paved portion also should be of sufficient width for two persons to pass without difficulty, and as much wider as the traffic calls for (see previous discussion of this subject).

Safety also demands that the sidewalk be not slippery and that it have no considerable projections above the uniform surface, or holes or other depressions below it, or any other features which might cause falls. It should be impossible for vehicles to drive onto it, except in crossing it over the driveways of livery stables, garages, etc., which, however, should be limited to the least number practicable. The width considered necessary for the sidewalk traffic should not be obstructed by show cases, signs, packing boxes or other temporary or permanent structures or obstacles placed thereon; nor should there be projections overhead such as awnings, signs, etc. low enough to strike the hats or even the umbrellas of those desiring to pass under them, nor any overhead projections which are not abundantly safe from falling.

The cross-slope of sidewalk necessary to drain it has already been considered. The average longitudinal slope of a given stretch of sidewalk is to a large extent determined by the grade of the roadway; but it is not necessarily parallel to this. Since quite steep sidewalks are apt to be slippery, especially in winter, some cities have mounted steep hills by using a succession of steps and flattened grades alternating. Steps are generally objectionable where there is much traffic, but this is not likely to occur on steep hillsides and there are arguments in favor of this use of steps in such locations. One western city has introduced the novelty of making concrete sidewalks on steep hills with cleats or projections of concrete a little over two feet apart extending across a part of the sidewalk to be used when the remainder of the sidewalk is too slippery for safe walking.

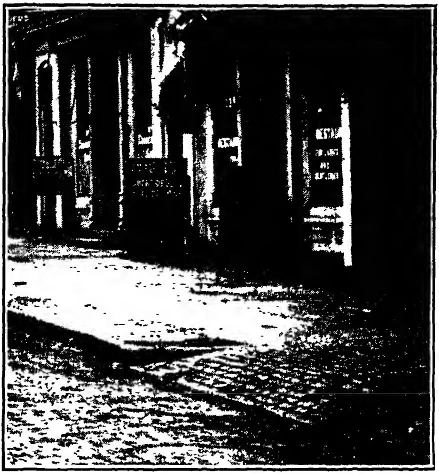
SIDEWALK MATERIALS.

The securing of dry sidewalks by evenness of surface is possible under any topographical conditions, being

pavement with a moderate cross-slope will rapidly shed all water which comes upon it; also if made fairly dense, it will dry out more rapidly than brick or wood, although not so rapidly as the very fine-grained stones, such as bluestone flagging. Sawed stone or natural stone otherwise brought to a uniform surface may perhaps even excel concrete in smoothness so far as the individual stones are concerned; but in 999 pavements out of a thousand the stones are not set so evenly or solidly that depressions are not formed or do not afterward occur. Brick sidewalks and those of tiles also, unless they are laid upon a concrete foundation, are almost sure to develop depressions which will hold puddles of water. Hard brick or suitable tiles, however, have in some cases been laid on a concrete base (say about 3 inches thick) on a well rolled earth foundation and the joints filled with cement, which have had and retained an excellent smooth surface. These, however, are more expensive than a well-made concrete sidewalk.

In some sections of the country where lumber is one of the chief products, wooden sidewalks are quite extensively used, and may be cheaper in first cost than any other kind. As ordinarily made, however, they do not keep an even surface; the planks, unless quite narrow, warp concave on top and hold water, they quickly rot or wear out, or are broken, and for these reasons are not convenient and are very frequently unsafe. Even where their first cost is much less than that of other materials, their ultimate cost will almost always be found to be greater, especially if there be included in this cost the judgments and legal costs which the city has had to pay as a result of damage suits brought because of accidents caused by defects in such walks. One western city reported one year an average of $14 per mile as the cost of judgments and defence in damage suits due to wooden sidewalks, although it had spent $39 per mile for inspecting and repairing such walks; thus making a total annual cost of about one cent per lineal foot for maintenance of a walk which at the best was inferior in convenience. As improvements in methods and materials

have made it possible to secure at reasonable cost almost perfect smoothness and safety in sidewalk construction, the courts have shown a tendency to uphold the right of citizens to expect such walks and to demand damages for any injuries which can be shown to have been caused by irregularities or defects in sidewalks; frequently ruling that, with the general introduction of smooth pavements, pedestrians are not now called upon to expect or guard against such irregularities as a few years ago would have been considered reasonable. If constructed so as to be reasonably safe and durable, a plank sidewalk will cost



Courtesy, U. S. Wood Preserving Co.

FIG. 141.—SIDEWALK DRIVEWAY PAVED WITH BRICK, QUICK RISE.

at least six or seven cents a square foot, while a good concrete sidewalk can be built for at least double this amount. The plank sidewalk, however, will not have an average life of more than four or five years, while a concrete sidewalk will last indefinitely and certainly two or three times as long as the plank walk. Thus, even omitting any legal expenses incurred, the plank walk is

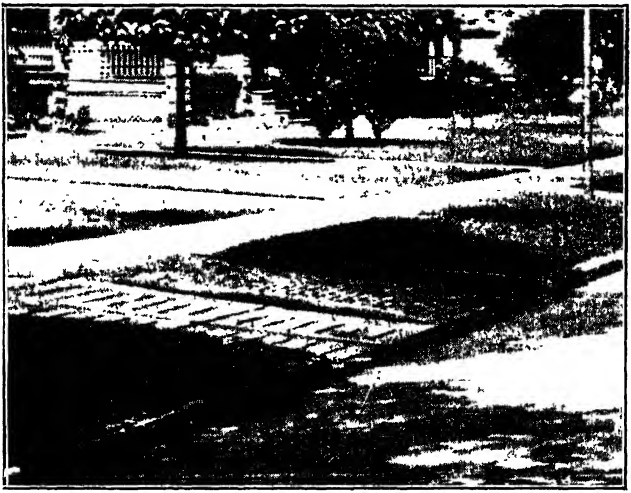
apparently more expensive than the concrete one and is much less comfortable.

DRIVEWAYS ACROSS SIDEWALKS.

Driveways across sidewalks to permit vehicles to pass from the roadway to the abutting property are necessary in all parts of the city where alleys are not provided. In the business districts fire houses and garages require them, and many stores and practically all factories find them necessary. These driveways present two problems of construction, one as to the material to be used, and the other the vertical location so as to permit teams to pass from the roadway up onto the sidewalk and at the same time interfere as little as possible with the uniformity of surface necessary for the safety and convenience of the pedestrians. As to the former, the difficulty is not great, but the observance of the requirements is too often overlooked. Many cities allow owners to pave these driveways with cobblestones or other rough stones which will afford a good foothold to horses, but which are very inconvenient for pedestrians. There are plenty of street pavements which, although especially adapted for vehicles, are both safe and comfortable for foot passengers, and any of these might be used for driveways across sidewalks. Among these may be named concrete, paving brick on a concrete base, smooth stone block pavement, sheet asphalt, and bituminous concrete. Whichever material is used, it should be laid on as solid a foundation as a roadway and be given a surface as uniform as it is possible to make it. Concrete may be provided with grooves running longitudinally of the sidewalk to afford a foothold for horses, which grooves will not inconvenience foot traffic if the remaining area is brought to a uniform surface and the grooves are made not more than ½ inch in width.

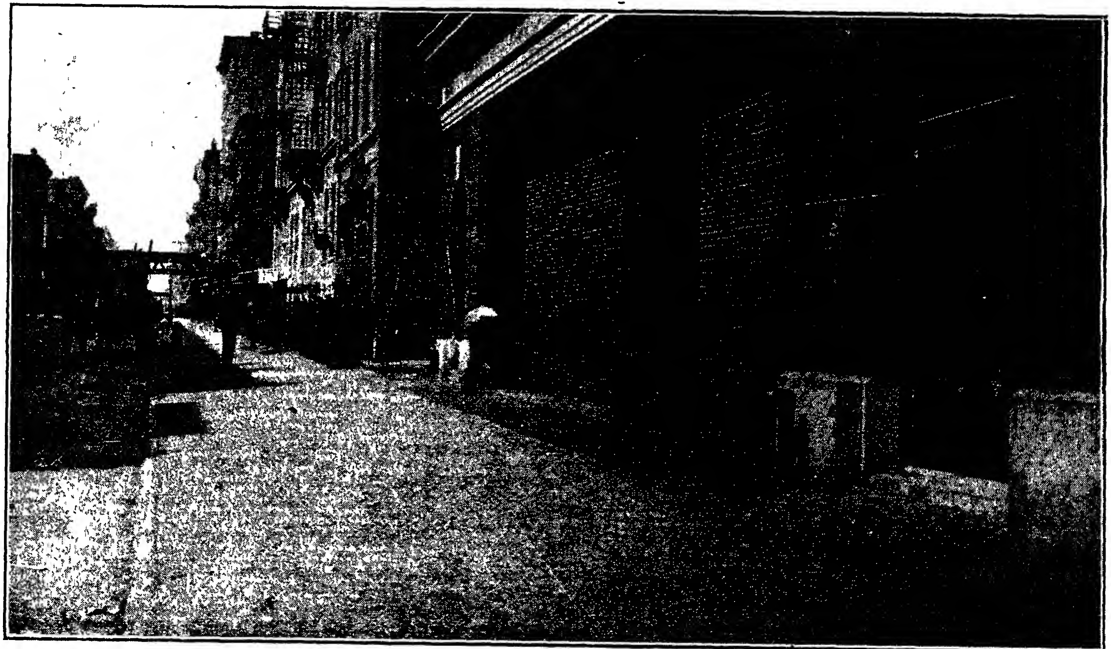
The problem of providing that the vehicles may rise from the elevation of the roadway to that of the sidewalk is a more difficult one under some conditions, especially in business sections where the sidewalk pavement extends entirely to the curb, or in residence sections where the pavement is placed next to the curb instead of being separated from it by a strip of parking. Possibly 6 inches

is the most common average height of curb. A driveway can, for the short distance involved, be made as steep as one in six (about a 17 per cent grade) and still give convenient service. This would require about 3½ feet (allowing for the slope of the sidewalk) to rise from the gutter elevation to that of the sidewalk. There are several advantages in beginning this driveway slope an inch, or possibly even two inches, above the gutter, one being that this confines the lesser flows of surface water to the gutter and prevents the stranding of floating matters on the driveway; and with reasonably large wheels there is no difficulty in passing from the roadway to the top of this 1-inch to 2-inch step in entering the driveway, while each inch of height of such step reduces the length of the incline by 6 inches and increases the width of uniform sidewalk surface by that amount. So little is gained by permitting a property owner to carry a uniform slope of driveway from the gutter all the way to the building line, and so much inconvenience is caused to pedestrians



Courtesy, National Paving Brick Manufacturers' Association.

FIG. 112—BRICK AND CONCRETE DRIVEWAYS. FLAT RISE STEP AT CURB



Courtesy, U S Wood Preserving Co.

FIG 143 —COMMERCIAL DRIVEWAY ACROSS ENTIRE SIDEWALK, SMOOTHLY PAVED. STEP AT CURB.

Bush Terminal Building, East 29th St., New York.

by this break in the sidewalk surface for its entire width, that such construction should not be permitted.

In residence districts this sloping portion of the driveway may be permitted to occupy the entire width of the planting strip, and this is one argument in favor of locating such strips between the sidewalk and the curb and for giving them a width of at least 5 feet. Where the sidewalk pavement is placed next to the curb the matter of driveways becomes a serious problem. The pavement frequently is not more than 5 feet wide, and if three feet of this is occupied by the depressed incline of a driveway, leaving but 2 feet of continuous surface of sidewalk, foot traffic is seriously inconvenienced. In the majority of cases in a residence district such driveway would be used only three or four times a day, on the average, and then by carriages and other light vehicles which can easily mount a steep rise or even a considerable step; and for such locations it is recommended that a step of 2 inches be provided at the gutter and that the slope of the driveway be increased to one to four; which would reduce the width of such slope to 17 inches with a 6-inch curb or 8½ inches with a 4-inch curb.

Another method of solving this problem is the use of gutter bridges, either permanent or temporary. The former are more or less common along earth or macadam roadways in residence sections. Such bridge interferes with the use of the roadway close to the curb, and also dams up water flowing in the gutters when it exceeds the amount which can be carried by the opening under the bridge, which frequently consists merely of a 6-inch or 8-inch pipe. Such pipe, moreover, frequently becomes stopped with dirt and leaves so that the run-off from every considerable rain is dammed behind the bridge until high enough to flow around its outer end, which flow results in a washing out of the dirt or macadam at this point and creating an objectionable and dangerous condition in the roadway. A permanent bridge of planks resting on timbers or light steel beams is preferable for residence sections in that it furnishes a much larger waterway beneath it and can be raised or removed at any time for clearing out dirt or other obstructions; the wooden

bridge, however, is generally less pleasing in appearance than the permanent bridge.

In business districts temporary bridges are frequently used for passing from roadway to sidewalk driveway, these consisting simply of three or four heavy iron straps, which are placed across the gutter, one end resting on the curb and the other on the roadway, to which are screwed or bolted planks making a bridge about 2 feet long and 10 or 12 feet wide; the iron straps being given a double bend at the end which rests upon the curb, so that, when set into depressions cut about a half inch deep in the curb to receive them, the top of the plank will be flush with the top of the curb. These bridges can easily be placed and removed and when not in use can be kept just inside the building line where the driveway crosses it, thus leaving the gutter perfectly free for carrying water or for vehicles to use the full width of the roadway.

CHAPTER XXVIII.

SIDEWALK OBSTRUCTIONS

In addition to driveways across sidewalks, there are found in most cities breaks in the uniformity of sidewalk surfaces in the form of cover plates to manholes, valve and meter boxes and other openings in the sidewalk. There is no reason whatever why any of these should be allowed to protrude above the level of the sidewalk, and yet millions can be found in the country rising from 1 inch to even 3 or 4 inches above the sidewalk level. The United States government maintains such a nuisance in one of the busiest sidewalks in the world, in the form of a large square cover to a vault opening raised 3 or 4 inches above the sidewalk of Broadway in front of the post-office. Up to a year or two ago a saloon on 23rd street was allowed to maintain eight coal holes in the middle of the sidewalk protruding more than an inch above the surface of the same; and similar instances could be found by the thousands in almost any large city and probably by the score in most small ones. Such projections ought not be permitted in the adjoining roadway surface, and the city officials should have as much consideration for the pedestrians who use the sidewalk by the thousand as for the vehicles which use the roadway by the dozens.

These manhole covers not only should have their surface flush with that of the sidewalk (and this means that their tops must be flat, and not crowned or mushroomed as many of them are), but the top surface should also be rough enough to avoid being slippery but not enough so to be inconvenient to walk on. A cover with its top formed of pyramids 1/8 to 1/4 of an inch high and 1/4 to 3/8 of an inch square at the base, the bases touching and the grooves between the pyramids being continuous,

will give just about enough roughness to avoid being slippery until the pyramids have been worn down half their depth, while the continuous grooves will catch a minimum amount of dirt and permit easy cleaning with a broom. Another form of covering which is not generally so durable but is even more comfortable for walking is one with a pan-shaped depression about 2 inches deep over the entire surface except the rim, the depressed part being filled with Portland cement mortar, well compacted and given a regular sidewalk finish. It is well to make no provision for raising any of these covers from above, but they should be removable only by lifting from below; otherwise burglars or others might use them for unauthorized access to the building.

The tops of storm water inlets, when set in the sidewalk pavement, are generally most satisfactory from the points of view of both appearance and convenience to pedestrians when made of the same materials as the sidewalk—generally concrete or stone. In some cases, however, when the sidewalk is paved with stone flagging, stone of the same kind can not be obtained of sufficient thickness, or is not sufficiently hard and tough to permit the edge of the inlet top to serve as a curb; then another kind of stone or perhaps concrete may be used and is preferable to iron. Where there is a sodded strip around the inlet top, however, cast iron, which is generally smaller and less obtrusive than stone or concrete, is more satisfactory.

Rain water led from roofs by leaders is best discharged into storm sewers, where there are any, by underground pipes. Where there are no storm sewers (house sewers should not be used), the gutters seem to be the only alternative. A 4-inch pipe is probably the largest which can be used for carrying the roof water under the sidewalk to the gutter. These pipes are apt to freeze shut in winter in northern climates, and to clog with dirt in all seasons and sections. As an alternative, sidewalk cross-gutters are often used, either open or closed. The former consist of depressions from ½ inch to 2 inches deep, which will carry the run-off from light showers but are of little avail in heavy rains. They also are some-

what of an inconvenience to pedestrians. Both objections are to a large extent met by the larger covered gutter. This is made 4 to 6 inches deep and wide, with vertical or nearly vertical sides, and is covered with an iron plate. The gutter itself is sometimes a cast iron trough set in the ground; but one of concrete is probably more common. The cover plate is generally of cast iron in two or more sections, and sets flush with the sidewalk. If one of these gutters becomes choked with dirt or ice it can be cleaned by removing the cover plates. If the gutter or trough be made narrower at bottom than at top, ice can be removed more readily. The chief objection lies in the possibility that the cover plates will be broken or dislodged. They should be strong enough to avoid the

Courtesy U. S. Wood Preserving Co.

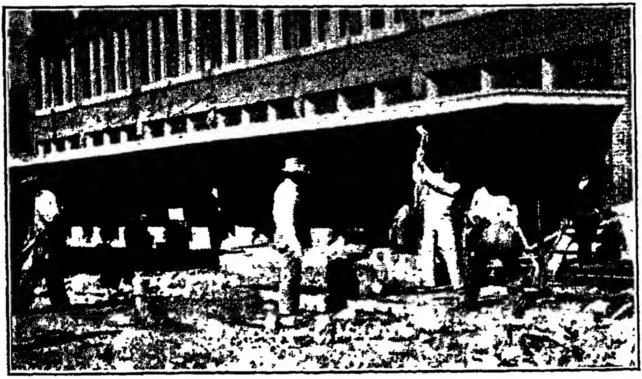
FIG 144—TREES TOO NEAR STREET LINE

Given these poles, there seems to be no good reason why letter boxes and fire and police alarm boxes should not be fastened to them. Street-name signs also can be placed on such poles where there are any at the street corner; otherwise it may be desirable to erect a short pole at the curb intersection for the purpose.

Where there are no poles it would seem to be unnecessary to place posts for letter and police alarm boxes, but these can be attached to buildings or fences at convenient points. Ordinarily little difficulty is experienced in obtaining permission of private owners to do this. If there is such difficulty, a simple post (say of angle or T iron) can be placed for this purpose an inch outside the building line.

Large litter cans or trash receptacles are perhaps best placed along the property line also, or in the sodded or planting strip along the curb where there is one. Ordi-

FIG 147.—LETTER BOX ON FENCE



Courtesy E. L. Marek.

FIG. 148.—SELF-SUPPORTING AWNING IN SAN ANTONIO.

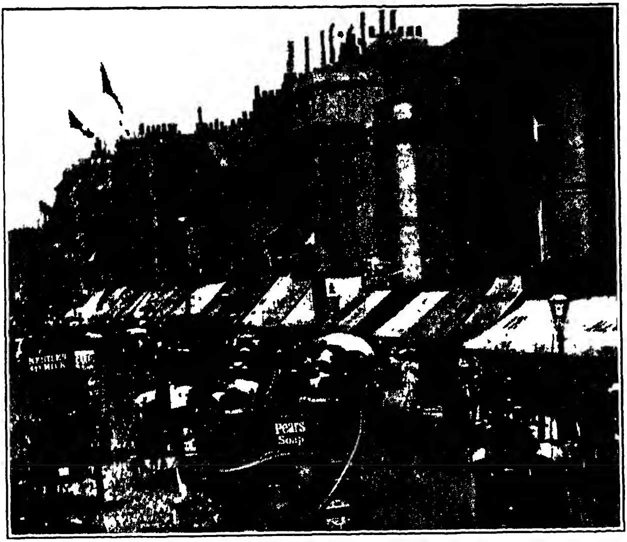
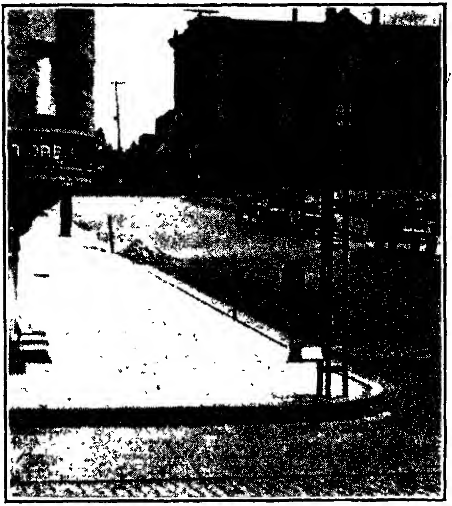


FIG 149.—STREET DISFIGURED BY AWNINGS
Regent Street, London

FIG 150—ROUNDING SIDEWALK CORNER AT INTERSECTION OF MAIN TRAFFIC STREETS.

narily, however, each one should be located with special consideration of local conditions—where there are likely to be the most papers, fruit skins, etc., to be thrown away, as in front of the post office, near fruit stands and the like; but also where they will least inconvenience pedestrian traffic. Some cities use as litter receptacles small cans (as in Washington, D. C.) or wire baskets (as in Manistee, Mich.), fastened to telegraph or electric light posts.

More seriously obstructive of the sidewalk are numer-



Courtesy Warren Bros. Co.

FIG. 151.—TRASH RECEPTACLE ON ELECTRIC LIGHT POLE.

ous kinds of structures and materials placed by abutting owners, aside from extensions of the buildings themselves onto public land. Among these are awnings. In a great many cases the awnings themselves are so low as to inconvenience pedestrians of even average height, while

of the street if uniformity of height, width and pitch could be enforced also. How a street may be disfigured by numerous awnings of various heights and angles is seen by the photograph of Regent street, London. Permanent awnings of wood or metal supported by posts at the side away from the building are common in some cities. These afford to pedestrians shelter from sun and rain and are generally abundantly high; but the posts should be kept small and out at the curb line so as not to obstruct the sidewalk. Hotels and theatres are the most common offenders in this respect, some using heavy masonry columns to support elaborate roofs over the sidewalks. Better than using even light iron posts is it to support the awnings from the buildings, either from below by brackets or trom above by rods or chains.

Temporary obstruction of sidewalks by boxes, crates and other forms of freighted goods may not appear to be a matter of street construction, but in a sense it is. For the merchants must receive or send off goods, and to do so must transfer them from store to vehicle. If the street offers the only route by which vehicles can reach a building, then the goods must be carried across the sidewalks. If paved alleys were carried through the center of each block, giving access to the rear of each store, this use of the sidewalk could be prevented. This is perhaps the strongest argument for alleys in the business part of a city.

The sidewalk itself may be an obstruction to the roadway traffic, as at corners, where sharp curb intersections should be rounded to permit vehicles to turn the corner from and to the part of the roadway near the curb. The accompanying photograph, on which has been drawn the lines of the curb carried to an angular intersection, show how greatly traffic is convenienced by rounding the curb intersection with a long-radius curve.

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